1993
Report to Congress

on the

Theater Missile Defense Initiative (TMDI)

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Executive Summary

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Basis

Section 231 of the National Defense Act For Fiscal Year 1993 (Public Law 102-484) directed establishment of a Theater Missile Defense Initiative (TMDI)[1] office within the Department of Defense (DoD) to carry out all DoD theater and tactical missile defense activities. The Act also requested an updated master plan for the TMDI that includes

> ***". . . a detailed consideration of plans for theater and tactical missile defense doctrine, training, tactics and force structure, and a detailed acquisition strategy which includes a consideration of acquisition and life cycle costs through the year 2005 for programs, projects and activities associated with TMDI."***

In response to this direction,

(a) in January 1993, then Secretary of Defense Cheney assigned the TMDI to the then Strategic Defense Initiative Organization (SDIO)[2] to ensure the benefits of complementary technology development and to preclude duplication of effort, and

(b) this report is the updated master plan which presents the background, guidance, and rationale for the acquisition strategy and architecture being developed under the TMDI. Since TMDI is, with the exception of PATRIOT, in the very early stages of definition and acquisition with doctrine and requirements not yet finalized and validated, it is premature to address subjects such as training, tactics, force structure, and life cycle costs in this report. As information on these subjects becomes available, it will be included in annual updates of this master plan.

In February 1993, Secretary of Defense Aspin issued policy and programming guidance to the Director, SDIO for building the FY 94 program budget, stating in relevant part,

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[1] When abbreviations are introduced, they are spelled out on first use; when a common acronym is used, it is not first spelled out. Abbreviations and acronyms are identified at the end of this report.

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[2] On May 13, 1993, Secretary of Defense Aspin announced the renaming of the Strategic Defense Initiative Organization (SDIO) to Ballistic Missile Defense Organization (BMDO). In this document, all references to previous actions or events will use the term Strategic Defense Initiative Organization or SDIO.

- Theater Ballistic Missile defense programs should be given highest priority and should be pursued on a prudent event-oriented schedule that provides for adequate testing prior to major deployments.

Background

Since its inception, SDIO/BMDO has addressed technologies that will lead to capabilities against threats posed by nuclear ballistic missiles of all ranges. Working with the military departments and allies, SDIO initiated several theater architecture studies that included other ballistic missile threats and laid the foundation for development of TMD element capabilities.

Congressional and Executive Branch actions in FY 93 continue recent emphasis on providing theater and tactical missile defense capabilities. In January 1991, the President redirected the Strategic Defense Initiative (SDI) program from its previous focus -- deterrence of a massive Soviet ballistic missile attack -- to protection of the United States, its forward deployed forces, and its allies and friends from limited ballistic missile attack. Congress enacted the Missile Defense Act of 1991 as part of the National Defense Authorization Act for Fiscal Years 1992 and 1993, stating in the Act that it is

> ***". . . a goal of the United States to provide highly effective theater missile defenses to forward deployed and expeditionary elements of the armed forces of the United States and to friends and allies of the United States."***

In response to related Congressional direction, DoD submitted its plan for meeting this TMD goal to Congress on July 2, 1992.

The 1992 Act also directed the Secretary of Defense to aggressively pursue the development of advanced theater missile defense systems, with the objective of down selecting and deploying such systems by the mid-1990s. Although the FY 1993 Authorization Act deleted the mid-1990s reference, the Conference Report directed the Secretary to develop advanced TMD deployments consistent with sound acquisition procedures and in accordance with a low-to-moderate technical risk and low-to-moderate concurrency program.

The conferees noted that the TMD baseline program contained in the Secretary's July 1992 report constituted such a program. The conferees specifically endorsed SDIO plans to develop, test, and field User Operational Evaluation Systems (UOES) prototypes for the THAAD system by 1996. Assignment of the TMDI to SDIO reflects conference report considerations.

Presidential and Congressional emphasis on developing systems to provide protection to the U.S. against limited ballistic missile attacks and to forward deployed forces, friends and allies required a shift in SDIO priority from broad-based research to an acquisition oriented mission, more closely allied with Service missions and capabilities. In the spring of 1992, SDIO and the Military Departments executed a Memorandum of Agreement (MOA)

establishing an acquisition structure headed by a General Manager reporting to the Director, SDIO.

In accordance with the MOA between SDIO and the Services in the spring of 1992, a new acquisition structure has been established under a General Manager (GM). Reporting to the General Manager, the Assistant General Manager (AGM) for Theater Defense has been designated as the DoD office to execute the TMDI and has prepared this plan.

The Mission Needs Statement (MNS) for TMD, validated by the Joint Requirements Oversight Council (JROC) which is chaired by the Vice Chairman of the Joint Chiefs of Staff, describes three types of missile threats: theater ***ballistic*** missiles, ***cruise*** missiles, and ***air-to-surface*** missiles. The required operational capabilities of an effective TMD are grouped into the four areas: counterforce (or attack operations); passive defense; active defense; and command, control, communications and intelligence (C^3I). The MNS states that all of these are required to ensure the U.S. has the capability to respond to the full range of theater missile threats.

Consistent with current focus of the TMDI, ***this plan deals almost exclusively with active defense and its associated C^3I against theater ballistic missiles (TBM).*** It does not address Service TMD programs outside the current scope of TMDI. These include a) defense against theater cruise missiles and air-to-surface missiles (although some of the elements discussed below have anti-cruise missile capabilities), b) aspects of the TMD pillars of counterforce, passive defense and C^3I not covered under TMDI, and c) integrating these aspects with other Service mission areas such as air defense, counter-air, and offensive air operation.

The Theater Ballistic Missile Threat

TBMs are becoming the long-range weapon of choice in regional conflicts, especially in the Middle East and Southwest Asia, where missiles have been used in four of the last six major wars. For future regional contingencies, a major implication that clearly emerged from the Gulf War is the political and military importance of possessing a defense capability to counter the threatened or actual use of ballistic missiles and weapons of mass destruction. The United States cannot accept a situation in which these TBM capabilities are either allowed to constrain a U.S. president's flexibility in employing military power when necessary to support national security objectives and commitments abroad or to pose an unconstrained threat to deployed U.S. forces.

Today, over 20 non-NATO countries have ballistic missile capabilities. Many of the countries that are developing and/or acquiring ballistic missiles are also acquiring weapons of mass destruction. By the end of this decade, five to ten developing countries could have nuclear weapons, up to 20 could have chemical weapons, and ten could possess a biological weapons capability. These technologies pose a threat today that is largely regional in character; however, the trend of ballistic missile weaponry is clearly in the direction of systems of increasing range, lethality, and sophistication.

Overall Plan

As part of the U.S. effort to contend with the emerging ballistic missile threat, the general approach adopted by the TMDI is to improve the current active defense capability on an incremental basis by improving existing weapons and support systems while developing advanced systems that perform together either in a stand-alone mode or as an integral part of a larger TMD/NMD architecture. This will be accomplished as rapidly as feasible, consistent with sound acquisition procedures and with affordable acquisition and life cycle costs.

There are a number of candidate elements and systems either under development or proposed to achieve the essential TMD capabilities. A major objective of this Report to Congress is to provide a context for understanding how the TMD active defense architecture is being developed, derived and assembled, and how the various candidate elements fit into that architecture.

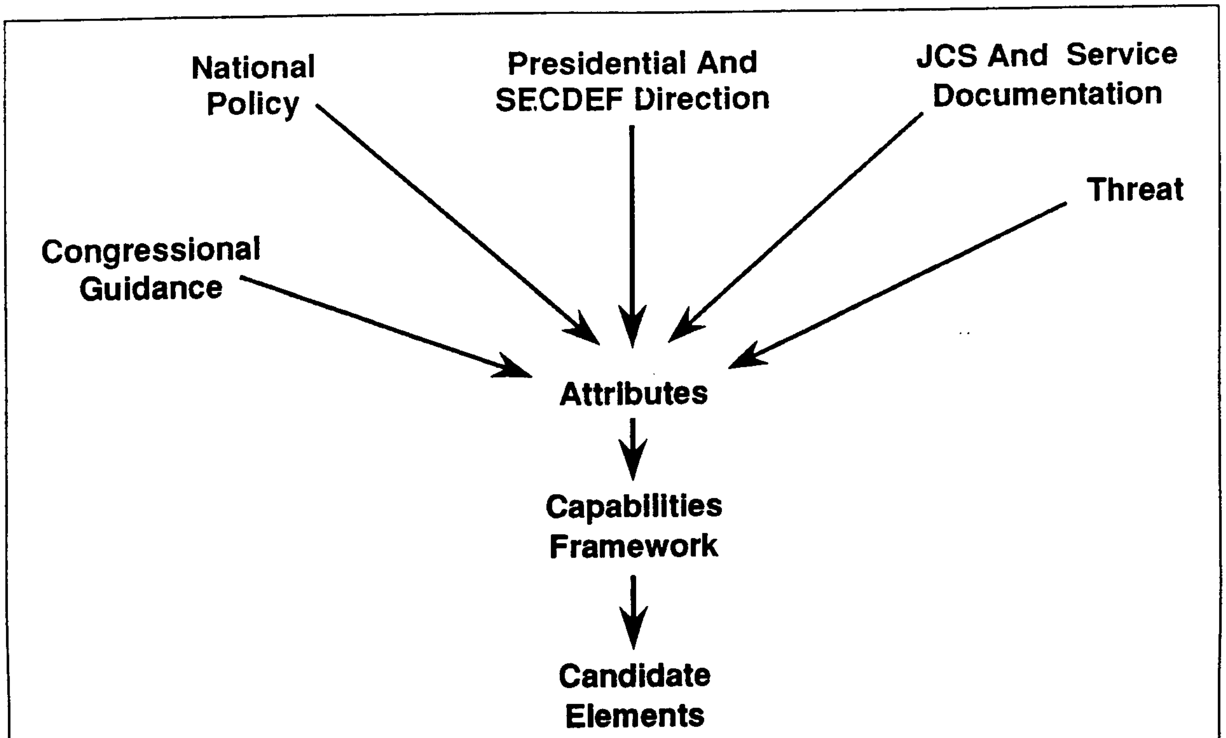
The candidate elements discussed in this report will compete for selection as part of the TMD architecture; a priority objective of the TMDI is to narrow down and acquire only those elements which meet military requirements, which are affordable, and cost-effective, and which provide essential value added.

Architectural Process

Defining the desired operational and technical attributes is an essential first step of the process of developing a TMD architecture and elements. Much of this definition can be derived from Presidential and Congressional guidance, from the existing MNS validated by the JROC and from approved Service Operational Requirements Documents (ORDs), as well as evolving requirement statements under consideration by the Services. Pending completion and validation of Service documentation specifying more detailed doctrine and operational requirements for TMD elements, attributes determination can be postulated on the existing and projected threat and the established national military strategy, and Secretary of Defense guidance. Figure EX-1 outlines the process.

On this basis, the TMDI has formulated a set of 17 **attributes**, grouped into four operational areas:

- ***deployment***
  - **capable of quick and easy movement by air**
  - **capable of forward deployment by ship in the crisis area**
  - **available for rapid utilization after deployment**
- ***employment***
  - **flexible to accommodate a wide range of operational locations and scenarios**



EX-1. TMDI Flow Down

- capable of tactical movement with troops and mobile military assets on the battlefield
- able to achieve a high degree of availability and sustainability
- provided with inherent survivability features in a variety of nuclear, biological and chemical (NBC) environments.

- *effectiveness*
  - provide early and accurate launch detection and impact point protection for civil and military units
  - provide extended surveillance ranges and altitudes
  - provide low leakage defense of assets and areas
  - provide a preferential defense capability
  - be effective against a range of TBM threats and resistant to enemy countermeasures
  - intercept missiles high enough to minimize effects from NBC debris.
- *integration*
  - with CINC and National Command Authority structure
  - with theater offensive operations
  - with theater air defense operations
  - to the extent possible with C^3I of allies or coalition partners.

On the basis of these attributes, a **framework** for the TMD architecture has been formulated in terms of five broad capability areas:

1) A **lower tier (terminal, endo-atmospheric) intercept** capability with both air transportable and sea-deployable capabilities to defend point and limited area asset targets.

2) An **upper tier (midcourse, high endo/low exo-atmospheric) intercept** capability with both air transportable and sea deployable capabilities to extend intercept envelopes, provide broader area defense, assure multiple intercept opportunities, and minimize the ground effects of unconventional weapons.

3) Capability for **boost phase intercept** (BPI) or intercept in early phase of flight to destroy missiles equipped with countermeasures and/or clustered warheads ***before*** their release or to destroy attacking missiles over the attackers territory.

4) Enhanced **warning and surveillance** capabilities including fixed and mobile tactical processing of launch detection data (from the Defense Support Program (DSP), follow-on early warning system (FEWS), or other means), extended midcourse tracking, and netted surveillance to support intercepts and broader defense coverage.

5) **Command, Control, Communications and Intelligence (C^3I)** capabilities to tie together and manage the above intercept and surveillance/warning capabilities and to integrate and coordinate TMD functions with the ballistic missile defense elements under study as part of the NMD.

A brief description of **elements** (or systems) under consideration for each capability area is presented below; further descriptions of the elements are found in the Appendix.

- **Lower Tier Intercept** -- PATRIOT upgrades, including ERINT or multimode missile, improvements to the Marine Corps TPS-59 radar and HAWK weapons system; Corps SAM; and modifications to the Navy's AEGIS system, including the SPY-1 radar, SM 2 Block IVA; and battle management and C^3I subsystems.

- **Upper Tier Intercept** -- THAAD with TMD-GBR, and sea-based systems utilizing either THAAD, LEAP-based interceptors, or other long-range interceptor concepts.

- **Boost Phase Intercept** -- A number of BPI possibilities incorporating various airborne and surface-based platforms and weapons have been suggested. A study of the concepts and technological possibilities is currently underway, along with a program exploring RAPTOR TALON, an unmanned autonomous vehicle (UAV) with a kinetic energy weapon.

- **Warning and Surveillance** -- Tactical processing of launch detection data is available from Talon Shield, Radiant Ivory, Tactical Surveillance

Demonstration (TSD), and the Joint Tactical Ground Station (JTGS); Brilliant Eyes is a longer-term addition for increasing surveillance ranges, improving cueing accuracy, extending interceptor engagement ranges, and attaining worldwide surveillance.

- C^3I -- Standardization of TMD messages; expanded use of TIBS (Tactical Information Broadcast System), TRAP (Tactical Receiver and Related Applications), and JTIDS (Joint Tactical Information Distribution System); upgrades to the Air Force Control and Reporting Center (CRC); and development of an Army Air Defense Tactical Operations Center (ADTOC).

The framework and elements are summarized in Figure EX-2.

Capabilities		Candidate Elements
Lower Tier Intercept	Ground-based	PATRIOT, HAWK, Corps SAM
	Sea-based	AEGIS With SM-2 Block IVA
Upper Tier Intercept	Ground-based	THAAD, TMD-GBR
	Sea-based	LEAP, THAAD, Other
Boost Phase Intercept		Various Platforms And Weapons
Warning And Surveillance		Launch Detection, BE, TPS-59
Command, Control, Communications, Intelligence		Message Standards, JTIDS, TRAP / TIBS, ADTOC, MCE Upgrades

EX-2. TMDI Capabilities Framework

The elements are in various stages of definition, development and acquisition. Some are large efforts and fall (or will fall) under the cognizance of the Defense Acquisition Board (DAB); others are smaller efforts. Some are already in the demonstration and validation (Dem/Val) phase; some are in concept formulation or definition. Finally, some are new systems; some are upgrades to existing capabilities. Details are available in the Appendix.

As previously noted, it is necessary to narrow down and acquire a subset of these elements. The TMDI plan is to subject these candidate elements to intense design, analysis, simulation and test over the next few years. Key factors in the TMDI acquisition strategy and selection process to be imposed on all candidate elements include their ability to:

- build on existing capabilities and investments in order to achieve a major increment of additional capability at the earliest date consistent with sound acquisition procedures; and

- achieve new and additional effective operational capabilities with affordable acquisition and life cycle costs.

Time-Phased Enhanced Capabilities

Three time periods have been selected to provide a time-phased reference for possible improvements to TMD capabilities.

In the near-term (FY 93-95), upgrades to PATRIOT PAC-2 and missile defense capabilities of the Marine Corps are programmed. Improved tactical processing and dissemination of launch detection data is already underway.

In the mid-term (FY 96-99), PAC-3 upgrades will further improve the PATRIOT system. This may include enhancements from the ERINT program or PATRIOT multi-mode missile. A sea-based PAC-3-like capability utilizing the AEGIS weapons system and the Navy's existing Vertical Launch System (VLS) to defend debarkation ports, coastal airfields, amphibious objective areas, and expeditionary forces as they are inserted ashore could be added.

Also in the mid-term, and to move beyond the inherent limitations of a point or limited area defense system, wide area defensive coverage using the THAAD interceptor system including the TMD Ground Based Radar (TMD-GBR) will be added. To respond to the Missile Defense Act mandate for fielding an advanced TMD capability, the option for a prototype THAAD "battery" or UOES at the end of the Dem/Val in 1996 for early operational assessment and possible deployment if a contingency requirement arises, is provided. This acquisition strategy was endorsed in the conference report on the National Defense Authorization Act for Fiscal Year 1993. ***Provision of the UOES is a major current thrust and priority of the TMDI.***

In the far-term (FY 2000+), sea-based TMD capability utilizing a longer-range missile could become available and could provide extended theater-wide footprints. The availability of Brilliant Eyes (the space-based sensor) could enhance the coverage of theater missile defenses by extending the range of THAAD and Navy interceptors by providing accurate midcourse cueing. Additional TMD capabilities could be added to the architecture in the form of the short-range Corps SAM and boost phase interceptors.

These planned or potential capabilities are summarized in Figure EX-3.

Capabilities		Near Term FY 93 - 95	Midterm FY 96 - 99	Far Term FY 2000+
Lower Tier Intercept	Ground-based	• PATRIOT PAC-2 Upgrades • HAWK (USMC)	• PATRIOT PAC-3	• Corps SAM
	Sea-based	——	• AEGIS SM-2 Block IVA • SPY-1 Mod	——
Upper Tier Intercept	Ground-based	——	• THAAD (UOES) And • TMD-GBR (UOES)	• THAAD (Objective) • TMD-GBR (Objective)
	Sea-based	——	——	• Sea-based TMD Interceptor • SPY 1 Upgrade
Boost Phase Intercept		——	• Airborne Laser Prototype	• BPI (Objective)
Warning And Surveillance		• TPS-59 • Tactical DSP Processing	——	• Brilliant Eyes
Command, Control, Communications, Intelligence		• Launch Detection, Data Dissemination • Standardized Interfaces	• AEGIS BM / C^3 Mod • Surveillance Data Netting • Communication Upgrades	• Theater Command Center Modifications • AEGIS BM / C^3 Upgrades • Cooperative Engagement

EX-3. TMDI Active Defense Candidate Capabilities

Acquisition Strategy and Structure

The TMDI will now proceed with the selection and acquisition of the elements and systems necessary to implement the capabilities or functions of the architectural framework within the projected funding of TMDI over the next ten years. The emphasis and criteria in the selection and acquisition will be, as noted, focussed first on upgrading existing capabilities and then on achieving a major increment of improvement via the plan for a UOES. The other key aspects of the acquisition strategy are to proceed with low-to-moderate concurrency and risk, and to leverage BMDO technology to the maximum extent possible.

TMDI will be a complex system and a challenging system acquisition problem. This complexity derives from the considerations that the TMD system must:

- be designed and configured to handle diverse, challenging, and evolving threats;
- operate in a variety of operational environments under a wide range of scenarios;
- accommodate new elements and systems from different Services; and
- integrate with an existing CINC command structure with existing capabilities and systems, many of which were designed to provide other functions.

To implement this complex acquisition, special organizational relationships and responsibilities have been adopted. The MOA between SDIO and the Services was intended to facilitate integration of TMDI activities among the Services and with the NMD activities of SDIO. Under the GM, the AGM for TMD provides central DoD management, direction, system engineering and integration, element selection, and allocates funding for the TMDI. The Services, acting as executing agents, implement the associated acquisition and inter-Service integration activities for individual elements and C^3I, sensor, and weapon capabilities.

An integral part of the acquisition strategy is a focus on early demonstration, test, and evaluation with a strong emphasis on simulation. In the very near term, a program to add TMD aspects to CINC exercises for training and doctrine development and to achieve early capability demonstrations and integration of multi-Service TMD systems is underway. This effort will also provide interim improvements in TMD and lay the groundwork for future upgrades.

A major simulation, test, and evaluation program is already underway. This includes several test bed developments, and integration and use of the National Test Facility (NTF) and National Test Bed (NTB). A Test and Evaluation Master Plan (TEMP) is being prepared for this activity.

Program Progress

Considerable progress was achieved in the TMD active defense program during the past fiscal year and first quarter of this fiscal year including the following:

- A major step in the upgrading of PATRIOT beyond the PAC-2 capability demonstrated in Desert Storm was achieved when the initial PATRIOT multi-mode missile and ERINT flight tests were successfully conducted.
- The THAAD and the TMD-GBR programs passed Milestone I, and major contracts were awarded for the Dem/Val phase of each.
- Navy participation in TMD took a major step forward with definition of a near-term and longer-term program.
- Contracts were awarded for the Talon Shield launch data tactical processing system, TMD upgrades to the Marine Corps TPS-59 radar, and for the Corps SAM concept definition studies.
- The TSD accomplished the first real-time stereo processing of launch data from DSP.
- The Passive Sensor System (PSS) demonstrated the ability to detect and track targets passively -- without disclosing its presence -- using radio frequency emissions from various transmitters.
- The CINCs TMD Experiments Program was marked by an extremely successful Questor Grail addition to EUCOM's Dragon Hammer 92 exercise.

- Collection of data to establish baseline lethality criteria for kinetic energy TMD weapons against conventional TBM warheads and weapons of mass destruction neared completion.
- The first of a series of TCMP (Theater Countermeasures Mitigation Program) tests to collect radar and infrared signature data on potential TMD countermeasures was successfully conducted in the Pacific.

The international TMD program in FY 1992 was marked by these events:

- The Israeli Test Bed (simulation facility) reached its initial operating capability.
- Successful Israeli Arrow flight tests were conducted on September 23, 1992 and February 28, 1993.
- The United Kingdom continued its architectural studies and its consideration a TMD policy.
- The analysis of TMD requirements in the western Pacific in and around Japan proceeded.
- Studies of TMD in NATO were initiated.

Key Milestones and Issues

Major near-term TMDI active defense architectural milestones are as follows:

- completion and validation of Service requirements documentation is expected to be completed during FY 93;
- an assessment of the next steps in achieving a BPI capability will be made in FY 93 following completion of the current study of this subject;
- identification of elements in the surveillance and warning and the C^3I capability areas should be largely completed in FY 93.

Major events in acquisition of TMDI capabilities in the remainder of FY 93 are currently planned as follows:

- Sea-based MS 0 DAB	July 1993
- THAAD OPINE (Operations in a nuclear environment) Decision	Summer 1993
- PATRIOT PAC-3 Missile Milestone IV DAB	Fall 1993

A key event in FY 93 will be the initiation of a program of near-term experiments and demonstrations. This will also be the first involvement of the CINCs TMD Initiative Program

with planning or executing three theater CINC (EUCOM, PACOM, CENTCOM) exercises in one year and with CINCSPACE providing support.

A major FY 93 issue relates to the ABM Treaty. As reported in recent SDI Reports to Congress, although the objective of the Treaty is to limit defenses against strategic ballistic missiles, there may be conflicts between the Treaty and the development and deployment of some of the TMD systems under consideration. These issues are currently under review; of specific interest is the DoD's ongoing review of THAAD.

Allied Cooperation

The TMDI program of international cooperative efforts involving friends and allies continues, covering a wide range of efforts such as the Israeli Arrow/ACES experiment program and NATO studies on TMD. Additionally, and to the extent feasible and desirable, the TMDI will support cooperative efforts with allies to ensure optimum missile defense efficiency through the assurance of interoperability of U.S. systems with future allied or friendly nation missile defense capabilities.

Funding

In FY 93, the TMDI budget was $1.102B. As THAAD and TMD-GBR enter the main phase of their Dem/Val activity, with continued funding of the PATRIOT upgrades and ERINT, and a major step-up in the Navy TMD effort, the TMDI budget request for FY 94 will be $1.807B. This amount incorporates efforts in six major categories: acquisition, architecture and analytical studies, technical support, test and evaluation, implementation and integration, and international programs.

* * *

Executive Summary in Review

- ***A major multi-Service and international TMD effort, focussed on active defense, is progressing at a fast pace.***

- ***Central direction of the TMDI is provided by the Assistant General Manager for TMD within BMDO.***

- ***A framework for the TMD architecture has been formulated, and an effort to select the most cost-effective elements to fit within this framework is underway and will continue over the next few years. This is proceeding in parallel with finalization of doctrine and operational requirements.***

- *The central thrust of the TMDI acquisition strategy is to*
  - *build on existing TMD active defense capabilities, and*
  - *provide an advanced TMD capability through availability of the THAAD and TMD-GBR UOES in 1996.*

Introduction

Introduction

This document, which accompanies the Secretary of Defense's FY 93 Report to Congress on SDI, is in response to requirements (1) and (2) of the FY 1993 National Defense Authorization Act for a report by the Secretary of Defense to the Congressional Defense Committees with the FY 94 budget:

(1) setting forth the proposed allocation of funds for [the Theater Missile Defense Initiative] TMDI for FY 94, shown for each program, project, and activity;

(2) describing an updated master plan for the TMDI that includes (A) a detailed consideration of plans for theater and tactical missile defense doctrine, training, tactics and force structure, and (B) a detailed acquisition strategy which includes a consideration of acquisition and life-cycle costs through the year 2005 for programs, projects and activities associated with TMDI; and

(3) assessing the possible near-term contribution and the cost-effectiveness for TMD of exo-atmospheric capabilities, to include at a minimum a consideration of:

(a) the use of the Navy's Standard Missile combined with a kick stage rocket motor and lightweight exo-atmospheric projectiles (LEAP), and

(b) the use of the PATRIOT Missile combined with the kick-stage motor and LEAP.

The response to item (3) will be contained in a separate and subsequent report to be available to Congress in July, 1993.

As noted within this document, the TMDI effort is proceeding rapidly towards an early operational capability and necessarily involves a concurrency of efforts that might otherwise proceed in a serial fashion. Since doctrine and operational requirements are not finalized or validated, it is premature to address subjects such as training, tactics, force structure, and life cycle costs. As information on these subjects becomes available, it will be included in annual updates of this plan.

It should be noted that the scope of this plan conforms to the scope and focus of the current TMDI effort; specifically

- the plan addresses ATBM capabilities but does not address the associated problems of the defense against cruise missiles or air-to-surface missiles;
- the plan focuses on active defense and C^3I pillars of TMD but does not

attempt to treat the counterforce and passive defense pillars in any depth or detail; and

- it does not address Service TMD programs outside the current scope of TMDI. These include a) defense against theater cruise missiles and air-to-surface missiles, b) aspects of the TMD pillars of counterforce, passive defense and C^3I not covered under TMDI, and c) integrating these aspects with other Service mission areas such as air defense, counter-air, and offensive air operation.

This document is consistent with but updates and replaces the TMD Report to Congress of March 1991 and the TMD material of the SDIO Report "Plan For Deployment of Theater and National Ballistic Missile Defense," forwarded to Congress on July 2, 1992. It provides significant additional information concerning the basis, status, and plans for TMDI. In that sense, it is an updated plan; however, it is not complete or final, nor is it a detailed acquisition plan.

A note as to usage in the material which follows:

- *theater* is used synonymously with *tactical*
- *counterforce* with *attack operations*
- *mobile* with *transportable*, and
- *ATBM* with *TMD active defense* against ballistic missiles.

Abbreviations and acronyms are identified at the end of this document.

Chapter 1

TMD Policy and Guidance

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TMD Policy and Guidance

This chapter begins with a short historic overview of the prior use of TBMs and then reviews those fundamental factors that most strongly influence and guide the TMDI: the threat, Congressional and Department of Defense guidance, and Service requirements documentation.

1.1 Historical Perspective

Theater ballistic missile defense first became a requirement towards the end of World War II with the introduction of the German V-2 long-range rocket. Designed as a terror weapon, the V-2 had a range of 300 km and used a mobile launcher. The first V-2s were launched against London from northern France in September 1944. (Somewhat earlier, in June 1944, the Germans introduced the V-1 "buzz bomb," a cruise missile of its day.) As launch sites in northern France were overrun by Allied forces, the Germans continued their attacks against London and later Antwerp from sites in and around The Hague, Holland. By the time the last launch site in Holland was overrun in March 1945, some 2,300 V-2s had been launched.

The V-2, many of which were recovered intact by Allied forces (including Soviet forces), was the direct forerunner of the Soviet Scud which has a similar design, range, warhead, and launcher. The subsequent use of Scuds or Scud variants is summarized in Figure 1.1-1.

Conflict	Year	Missile Type	Total Employed	Duration Of Campaign	Maximum Per Day	Targets
World War II	1944-1945	V-2	≈2,300	7 Months	26	Cities, Ports
Yom Kippur War	1973	Scud FROG	≈3 ≈24	Days 1 Month	1 24	Military Targets, Airfields, Troop Concentrations
Iran-Iraq "War Of Cities"	1980-1988	Scud / Scud Variants	≈350	52 Days	≈10	Cities, Economic Targets
Libya-Italy	1986	Scud Variant	2	Minutes	2	U.S. Military Facility
Afghanistan	1988-1991	Scud	≈2,000	2 Years	≈10	Villages, Troop Concentrations
Persian Gulf	1991	Scud / Scud Variants	≈90	6 Weeks	≈10	Population Centers, Troop Concentrations, Air Bases

1.1-1. Historical Uses Of Theater Ballistic Missiles

During Desert Storm, some 90 modified Scuds were launched by Iraq against Saudi Arabia and Israel. The PATRIOT PAC-2 deployed to Saudi Arabia and Israel provided the first successful active defensive capability in actual combat against TBMs.

Several lessons and conclusions pertinent to the TMDI can be drawn from the World War II and Desert Storm experiences:

1) TBMs of limited accuracy and conventional payload may not normally be considered as significant threats against military targets, but if used against cities, these TBMs can divert significant military resources to defeating the threat.

2) The wide dispersion of assets over a theater requires TMD systems that can provide long-range coverage, as well as short-range, close-in capability.

> ***'I underestimated the political impact of the Scud . . . A lousy weapon, a terror weapon' . . . A miscalculation . . . Defused only by the success of PATRIOT . . . PATRIOT success also has exposed a hole in the Allied arsenal, PATRIOT is a point defense weapon, and the areas to be defended in Saudi Arabia are concentrated in a few, small clusters. If the Allied military targets had been spread out, there 'wouldn't be enough PATRIOTS in the world to defend' them all.***
>
> ***In 15 to 20 years, when very accurate missiles with mass destruction warheads are available to third-world nations, the U.S. will need a regional, wide area air defense force to duplicate on a grand scale the PATRIOT's 'pivotal role of defanging' the Scud.***
>
> Lt Gen Charles A. Horner, USAF,
> Commander, U.S. Central Command Air Forces, interviewed in
> Aviation Week and Space Technology, February 11, 1991

3) Active TMD requires high-altitude, longer-range intercepts, preferably over water or uninhabited areas, to preclude damage to defended assets from debris, undetonated explosive warheads or undispensed chemical or biological agents.

4) Deliberate as well as inadvertent countermeasures cannot be ignored.

5) Regional conflicts can occur rapidly and with little warning, thereby requiring forward or rapid deployment of TMD systems to provide the necessary protection. PATRIOT is heavy and large, requiring a large amount of strategic airlift assets.

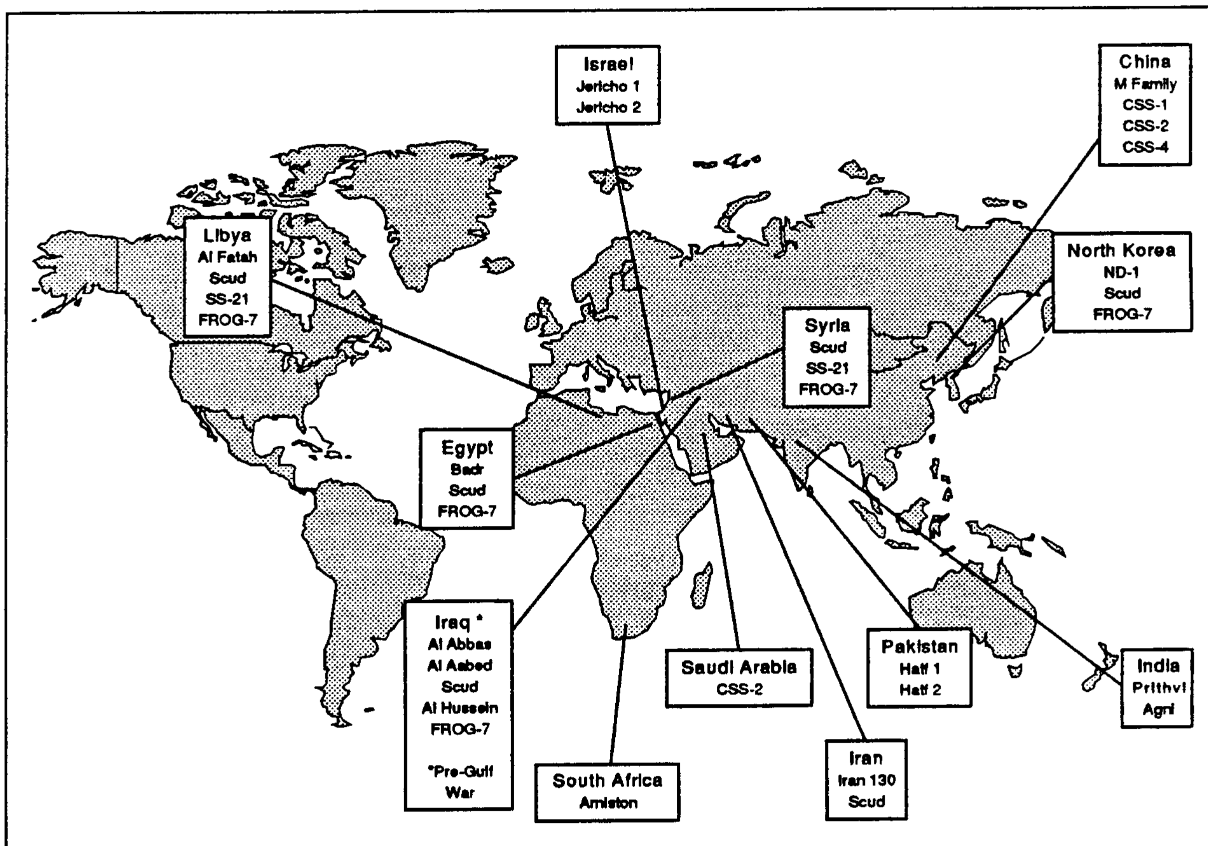
6) Destroying missiles on launchers is very difficult. Tactical camouflage, mobility, and concealment reduce surveillance effectiveness and result in lowered effectiveness of attacks on launchers. However, counterforce attacks contribute to, but do not substitute for, active defense by forcing the enemy to launch hurriedly ("shoot and scoot"), degrading the enemy's ability to mount a well-structured, lengthy attack.

1.2 Theater Ballistic Missile Threat

Ballistic missiles have become a common long-range weapon in regional conflicts, especially in the Middle East and Southwest Asia. Since their acquisition, missiles have been used in most conflicts in the two regions. A major lesson learned from Desert Storm and Desert Shield is the political and military importance of possessing defenses against ballistic missiles and weapons of mass destruction (i.e., nuclear, biological, chemical).

The TBM threat is evolving and is characterized by the use of increasingly higher levels of technical sophistication. The result will likely be improved accuracy, longer range, and warhead designs that include submunitions. Today, many developing countries have TBM capabilities. (See Figure 1.2-1.) There are over a dozen designs of TBMs with ranges from 80 km to 3000 km and with apogees from 20 km to over 600 km (from endo-atmospheric to exo-atmospheric). The exact size of the Third World missile arsenal today is difficult to determine, but the arsenal is in the thousands and is likely to increase in quantity and sophistication.

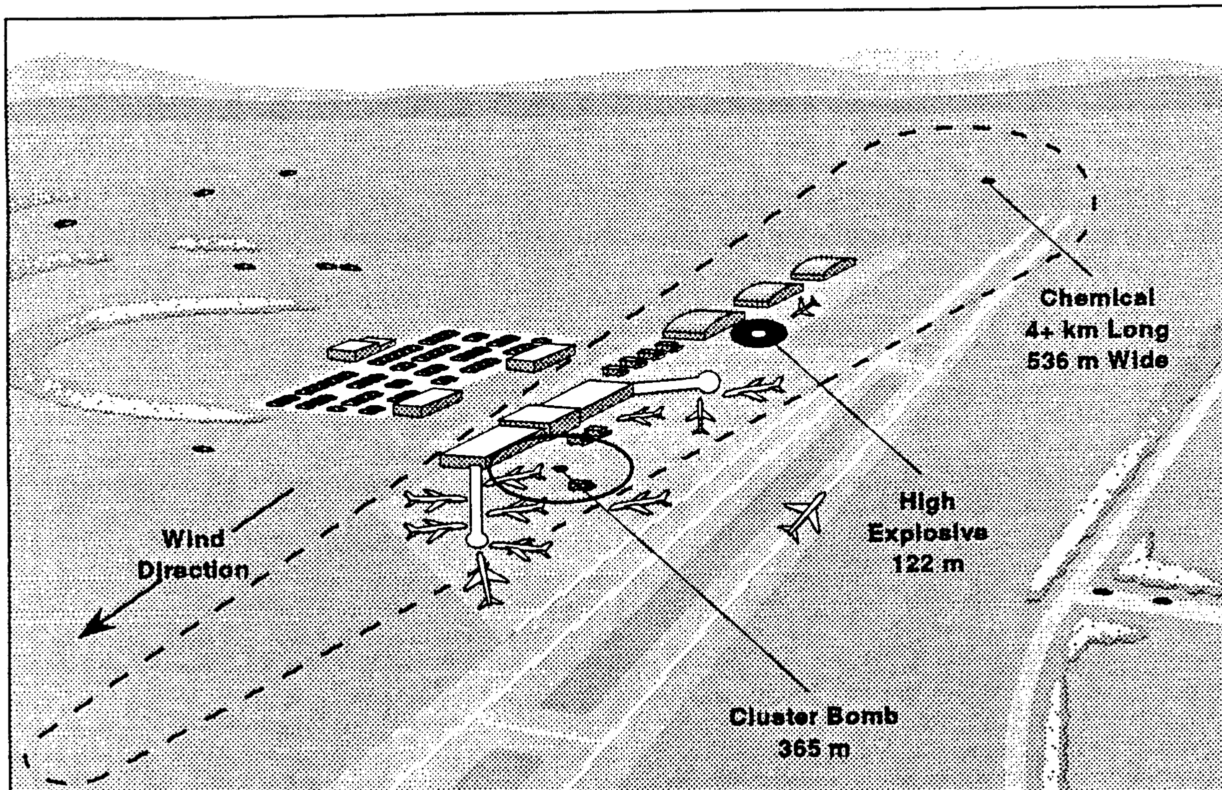
Other dimensions of the threat include diverse launching capabilities, warhead types, and countermeasures. Technically, ballistic missiles can be launched from fixed launchers on or



1.2-1. Illustrative Rest-of-World Ballistic Missile Programs

below the earth's surface, rail/road-mobile ground launchers, or ships and submarines at sea. Missiles may be armed with nuclear warheads or with chemical, biological, or conventional high-explosive warheads of both bulk and submunition types. Ballistic missiles may be maneuverable and have the potential to employ modern low observable technology, a variety of penetration aids and decoys, and a wide range of electronic and other countermeasures.

High explosive (HE) in bulk warheads on TBMs, while devastating to the immediate impact area, has a limited effective area. Clusters of HE submunitions released before impact can affect a wider area, but with proportionally lower blast and damage effect. Nuclear, chemical, and biological (NBC) weapons can destroy or render large areas unusable. Figure 1.2-2, adapted from an article in Scientific American (Vol. 263, No. 12, August, 1990) illustrates this point.



1.2-2. Effective Areas Of Chemical, High Explosive, And Cluster Warheads

The steady growth in the proliferation of weapons of mass destruction (nuclear, biological, and chemical) is of gravest concern. For decades, the international community has held the premise that the more countries that possess these weapons, the greater the likelihood of their use. According to a House Armed Services Committee Report dated April 1991, Defense for a New Era: Lessons of the Persian Gulf War:

> "The global proliferation of ballistic missile technology and weapons of mass destruction has become one of the most immediate and dangerous threats to U.S. national security in the post Cold War era. Over time, this threat will most likely

evolve from today's shorter-range, inaccurate missiles in the direction of more sophisticated, longer-range and increasingly accurate systems."

By the end of this decade, as many as five to ten developing countries could have nuclear weapons, approximately 20 could have chemical weapons, and approximately ten countries could possess a biological weapons capability.

Another aspect of the threat that concerns defense planners is the potential use of countermeasures to disrupt a TMD system and increase the probability of successfully penetrating the defense by an enemy warhead. There is a wide range of potential countermeasures ranging from those that are relatively easy and inexpensive to implement, to those which are more difficult and expensive. As an example of the former, Iraqi Scuds tumbled in their terminal phase of flight as a result of structural modifications made to achieve longer ranges. This tumbling motion initiated a series of inadvertent countermeasures that ended in some instances with the missile body breaking into many pieces. These followed unpredictable flight paths that made radar tracking and identification more difficult.

The spectrum of potential Third World countermeasures is broad and may include steps to introduce TBM decoys, to jam or evade TMD radars, or to mitigate the effects of the interceptor. Examples include separating warheads, fragmented boosters, stand-off or escort jammers, and a variety of decoys.

1.3 Congressional and Department of Defense Guidance

1.3.1 Congressional Guidance

Congress has provided guidance relative to TMD over the past few years with a focus on TMD importance, the need for central direction of TMD efforts in DoD, the establishment of a TMDI, and the need for early operational capabilities. The basic elements of the guidance are summarized below

In the FY 91 Appropriations Conference Committee Report, H.R. 101-938, Title IV, dated October 24, 1990, the conferees:

- asserted ". . . that research and development efforts in this important area [tactical and theater ballistic missile defense] need to be accelerated . . ." and that ". . . a U.S. tactical ballistic missile [defense] system with the necessary capabilities should be fielded as soon as technologically and fiscally feasible."
- acknowledged ". . . that it is premature to designate any particular weapons system or program as the baseline for a U.S. tactical ballistic missile [defense] system . . .," and ". . . that the selection of this baseline should be based on a fair and impartial evaluation of the cost- and military-

effectiveness, and technological capabilities, of the likely candidate weapons systems and programs."

- directed the Secretary of Defense ". . . to submit . . . his plan for determining the requirements for a baseline U.S. tactical ballistic missile defense system and for selecting this baseline . . . and for fielding a system." And ". . . that this plan be funded fully in the fiscal years 1992-1997 Six Year Defense Program."
- stated ". . . that this plan should include a full examination and inclusion, as appropriate, of the Navy and Air Force requirements for tactical ballistic missile defense systems and programs. The plan should outline how the Defense Department will integrate these services into the centrally managed programs to address their requirements."

The Conference Report called for the establishment of a centrally managed tactical ballistic missile defense research and development program under the auspices of the Office of the OSD.

In November 1991, the Congress provided additional guidance in the Missile Defense Act of 1991 (the name given to Sections 231 through 240 of the National Defense Authorization Act for Fiscal Years 1992 and 1993). Specifically, Section 232 states that it is a goal of the United States to ". . . provide highly effective theater missile defenses (TMDs) to forward-deployed and expeditionary elements of the armed forces of the United States and to friends and allies of the United States."

Other direction in the Missile Defense Act of 1991 included:

- The Secretary of Defense shall aggressively pursue the development of advanced theater missile defense systems, with the objective of down selecting and deploying such systems by the mid-1990s.
- The Theater Missile Defenses program element shall include programs, projects, and activities (including those associated before the date of the enactment of this Act with the Tactical Missile Defense Initiative) that have as primary objectives either of the following:
    1) The development of deployable and rapidly relocatable advanced theater missile defenses capable of defending forward-deployed and expeditionary elements of the Armed Forces of the United States, to be carried out with the objective of selecting and deploying more capable theater missile defense systems by the mid-1990s.
    2) Cooperation with friendly and allied nations in the development of theater defenses against tactical or theater ballistic missiles.

In the fall of 1992, Section 231 of the National Defense Authorization Act for FY 1993 stated that:

- "The Secretary of Defense shall establish a Theater Missile Defense Initiative Office within the Department of Defense. All theater and tactical missile defense activities of the Department of Defense, including all programs, projects, and activities formerly associated with the TMD program element of SDI, shall be carried out under the Theater Missile Defense Initiative."

The Conference Report accompanying the FY 93 Defense Authorization Act also directed the Secretary of Defense to:

- "Develop the advanced TMD and initial ABM deployments consistent with sound acquisition procedures and in accordance with a low-to-moderate technical risk and low-to-moderate concurrency program.
- Structure this development program with the objective of deploying such systems by the earliest date allowed by the availability of appropriate technology and the completion of adequate integrated testing of all systems components."

The 1993 Conference Report also noted that:

- "In directing this action, the conferees do not intend to rule out any arrangement the Secretary of Defense may determine is most appropriate for the management and program direction of the TMDI, including placing TMDI under the management and direction of the Director of SDIO. . . . .
- This direction is designed to avoid redundancy, to obtain both technological and financial efficiencies, and to maximize the incorporation of common technologies in specific theater and strategic missile defense systems.
- . . . the Secretary may use the authority to transfer a limited amount of funding . . . to help promote these efficiencies."

In addition, the Report endorsed "SDIO plans to develop, test and field UOES prototypes for the THAAD system by 1996."

The 1992 reports of the House Armed Services Committee and House Appropriations Committee recognized a contribution and role for the Navy in providing TMD and supported "aggressive exploration of promising concepts" for Naval TMD including cost effective systems that can be accelerated, as well as upgrades that might be fielded more quickly. In stipulating the funding for TMDI, Congress stated that not less than $90,000,000 be made available for exploration of promising concepts for naval TMD.

1.3.2 Departmental Guidance

With the demise of the Soviet Union, threats to stability in key regions throughout the world have become America's principal military concern and a major determinant of defense budget priorities. In addition to these regional dangers, the proliferation of weapons of mass

destruction and their means of delivery have also been identified by the Department as a major threat to the United States. It is the role of theater missile defenses in meeting these two dangers that will be at the core of the Administrations's planning in this area.

With respect to regional dangers, the threat of ballistic missiles in these regional conflicts has grown enormously over the past two decades. These missiles have been used in five regional conflicts since 1973 -- most recently during the Persian Gulf War. As the lessons learned from this experience (discussed above) indicate, more effective theater missile defenses are necessary to counter even greater ballistic missile threats in the future.

Compounding these regional dangers is the threat stemming from the spread of weapons of mass destruction to regimes hostile to the United States. The past several years have witnessed growing efforts by developing states, including some unfriendly to the United States, to acquire nuclear, biological and chemical weapons. Many of these nations already have some form of theater ballistic missile capability.

The combination of nuclear weapons with theater ballistic missiles poses a unique threat to managing future regional crises. An aggressor state may in the future be able to preclude or limit a conventional Western military response simply by threatening a nuclear strike. Such a threat may serve to deter us from projecting military forces to defend our interests. Or, it may serve to deter a neighboring nation from seeking our protection fearing a nuclear attack.

We cannot accept a situation in which the threatened or actual use of ballistic missiles constrains our ability to project military forces to support U.S. national security objectives and commitments abroad. Nor can we allow our forces, once deployed, to face an unconstrained threat from ballistic missiles.

To meet the potential challenges posed by theater ballistic missiles, particularly if they could be armed with nuclear or other weapons of mass destruction, the Department has identified theater ballistic missile defense programs as the number one priority in the ballistic missile defense program and stated that TMD should be pursued on a prudent event-oriented schedule that provides for adequate testing prior to committing to major deployments. Pending final review as part of the Department's overall bottom-up review of Defense policies and programs, three objectives have been identified in developing the TMD program.

The first objective is to deploy improved theater missile defense systems quickly. The threat that we are facing from tactical ballistic missiles is here and now. We need to deploy improved theater missile defenses as soon as possible. This means that at least one phase of our overall TMD effort should focus on upgrading existing systems to provide increased lethality, greater range and improved detection.

The second objective is to respond to likely new developments in the threat. In Operation Desert Storm, we faced a relatively short-range missile and no weapons of mass destruction were employed. In the future, both of these elements could change. Accordingly, we need to develop systems that can defeat longer-range missiles and that can intercept them before they could release nuclear, chemical or biological weapons.

The third objective is ensuring that theater defenses can meet the full range of missions needed. The Gulf War demonstrated that ballistic missiles threaten civilian, as well as military targets. To protect cities in future contingencies, we will need theater ballistic missile defenses that can protect a much wider area.

In short, the central goal is to develop theater ballistic missile defenses that will deny hostile forces the effective use of ballistic missiles in all aspects of regional conflicts.

1.4 Requirements Documentation

In April 1988, the JCS issued a Joint Tactical Missile Defense Operational Concept that focuses largely on the theater missile threat to the NATO Central Region. Subsequently in December 1991, Joint Publication 3-01.5, "Doctrine for Joint Theater Missile Defense," was issued in final draft.

In November 1991, the JROC validated the TMD MNS which states that "A theater missile (TM) is a ballistic missile (BM), cruise missile (CM), or air-to-surface guided missile (ASM) whose target is within a theater or which is capable of attacking targets in a theater."

The purpose of the MNS is stated as:

> ". . . to guide Service and joint doctrine, training, force design, and material developments, including other MNSs, to counter the TM threat. It should also guide cooperative efforts with U.S. allies."

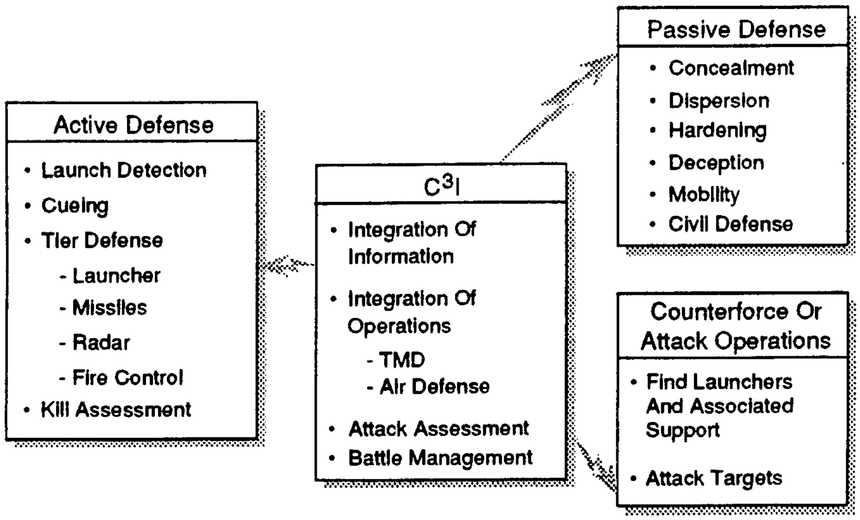
The document states the TMD mission as:

> ". . . to protect United States (U.S.) forces, U.S. allies, and other important countries, including areas of vital interest to the U.S., from TM attacks."

TMD objectives are further detailed as:

1) To prevent launch of TMs against U.S. forces, U.S. allies, and other important countries, including areas of vital interest.
2) To protect U.S. forces, U.S. allies, other important countries, and areas of vital interest from TMs launched against them.
3) To reduce the probability and minimize the effects of damage caused by a TM attack.
4) To detect and target TM platforms, to detect, warn and report of TM launch, and to coordinate a multifaceted response to a TM attack and to integrate it with other combat operations.

The MNS discusses TMD capabilities and strategies in four areas or pillars of capability as shown in Figure 1.4-1:



1.4-1. TMD Pillars

- **Active Defense** -- In-flight intercept and destruction of ballistic missiles and negation of their warheads.
- **Attack Operations or Counterforce** -- Destruction of the enemy's capability to launch missiles.
- **Passive Defense** -- Enhancement of the survivability of friendly forces and assets.
- **Command, Control, Communictions, Intelligence (C^3I)** -- Coordination of other pillars and integration of the entire TMD system into overall combat operations.

Further MNS guidance is given in six areas:

1) The TM threat cannot yet be countered by any single technical solution (e.g., PATRIOT, Corps SAM, ERINT, THAAD, and AEGIS/Standard Missile Block IV). It most likely will require a mix of land, air, sea, and space defense capabilities.
2) Solutions will require closely coordinated, joint and combined efforts, building on existing systems and doctrine, and when appropriate, incorporating the newest technologies and concepts.
3) TMD will require a balance of integrated attack operations, comprehensive active defense against missiles in flight, extensive passive measures, and a robust C^3I and surveillance capability responsive to unique TM characteristics.

4) Decisions regarding acquisition of TMD-unique systems must be weighed carefully against resource constraints and mission needs to include the requirements for countering the total threat.

5) When feasible, existing and planned air-defense and communications systems should be modified to also support countering the TM threat.

6) There is potential for allied cooperation in TMD.

On December 10, 1992, the JROC forwarded to the Under Secretary of Defense for Acquisition potential material alternatives to meet the Navy-identified need to ". . . provide a flexible, mobile, and highly responsive capability for the defense of amphibious objective areas, debarkation ports, joint combat and logistics expeditionary forces, and designated inland regions over an entire theater of operations." The JROC further stated that it believed that "this need comes under the TMD MNS . . ." and recommended that ". . . a DAB Milestone 0 review be convened to consider how to fill this need."

In further definition of the MNS and to support the Service acquisition efforts of individual elements, the Services currently are preparing ORDs. A High Altitude Theater Missile Defense (HATMD) ORD has been published by the Army and is guiding the THAAD and TMD-GBR procurements. Other ORDs are currently in preparation.

As additional operational concepts and doctrine become available and as additional Service ORDs are completed and validated, that material will be incorporated into this plan.

* * *

Chapter 1 in Review

Basic inputs to the formulation of the TMDI plans and architecture include:

- ***Historical lessons and experience in the use of TBMs: V-2s in World War II and Scuds in Desert Storm.***

- ***A new U.S. security policy with emphasis on regional conflict.***

- ***The current and evolving TBM threat, including weapons of mass destruction and countermeasures.***

- ***Presidential and Congressional guidance for central direction of TMD efforts and early deployment of TMD capabilities.***

- ***Service documentation and JROC validation of needs and requirements (still in process).***

Chapter 2

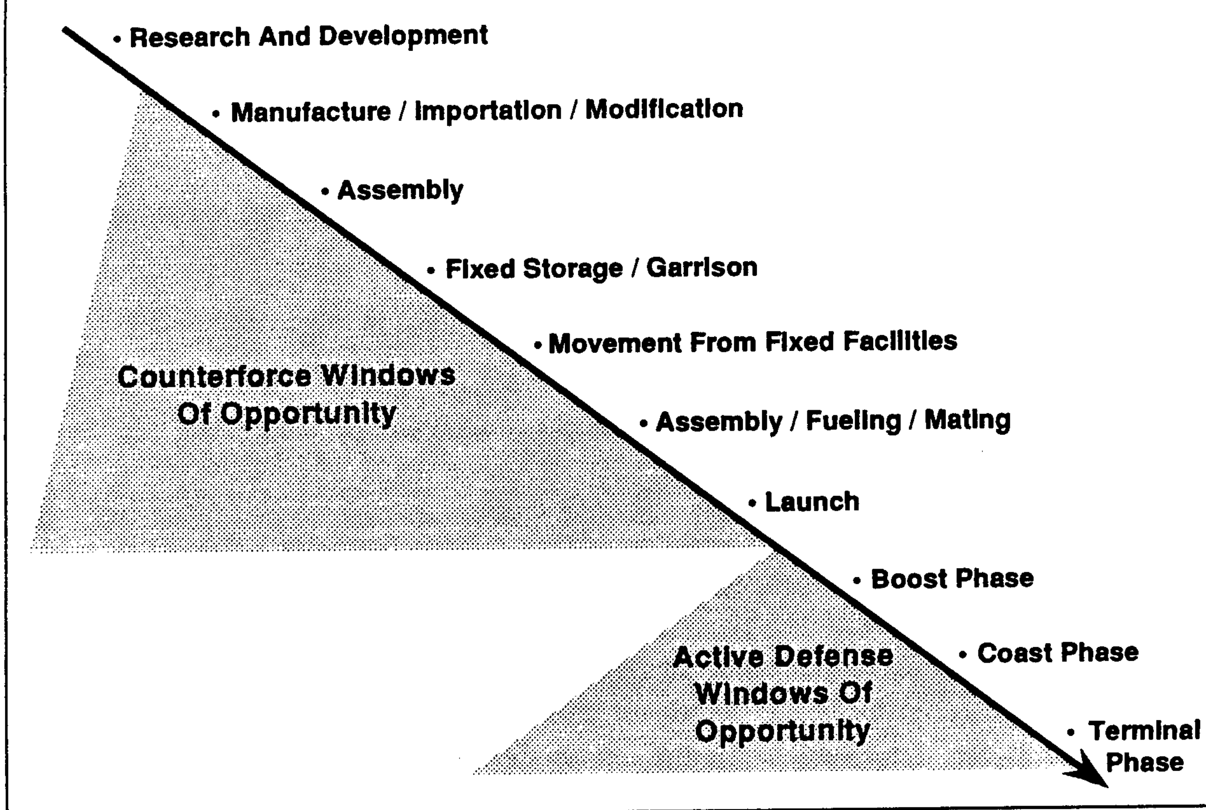
Time Lines and Attributes

Chapter 2
Time Lines and Attributes

This chapter first discusses the time lines and the opportunities for executing TMD in the active defense and counterforce pillars. The chapter then narrows its focus to the active defense pillar. The required TMD operational and technical attributes that strongly influence the TMD architecture are then summarized.

2.1 TBM Time Lines and TMD Opportunities

Figure 2.1-1 shows the generic time line of a typical TBM. Counterforce opportunities occur before missile launch; active defense opportunities occur after launch.



2.1-1. Lifetime Of A Theater Ballistic Missile

Counterforce has three windows of opportunity. The first opportunity is the fixed infrastructure, where the missiles, warheads, and transporter, erector, and launcher (TELs) are

designed, produced or procured, and ultimately stored. Just before or at the onset of hostilities, a potential enemy is likely to move his missiles, warheads, and TELs to new locations which he hopes are unknown and will, therefore, not be attacked. This is the second window: the forward support logistics infrastructure. The third window is the launch phase itself, during which a missile and warhead on a TEL are ultimately moved forward to the firing point and launched, after which the TEL leaves the firing point as rapidly as possible. The time-sensitivity of counterforce attacks increases significantly later in the TBM lifetime. Early in the life of a TBM, the time sensitivity is measured in months or years; a missile on a launcher has time sensitivities measured in minutes.

During the past five years or so, the Services (particularly the Army) have conducted studies, experiments and demonstrations relating to counterforce and passive defense and their associated C^3I elements. Some efforts have considered the integration and balancing within and among all four pillars of TMD. However, to date, the BMDO-managed TMDI program has focused almost exclusively on the active defense pillar and its associated C^3I, with little funding and in-depth study or analysis directed to passive defense or the exploitation of the counterforce windows of opportunity. Furthermore, no current or planned TMDI-funded efforts are uniquely aimed at developing the required sensors, weapons and other capabilities which could successfully attack targets in those windows. However, there are Air Force funded efforts to enhance TMD counterforce capabilities to find TMD targets, task available resources, and attack and destroy the targets. Consequently, this report will not further address counterforce or passive defense, but does recognize that:

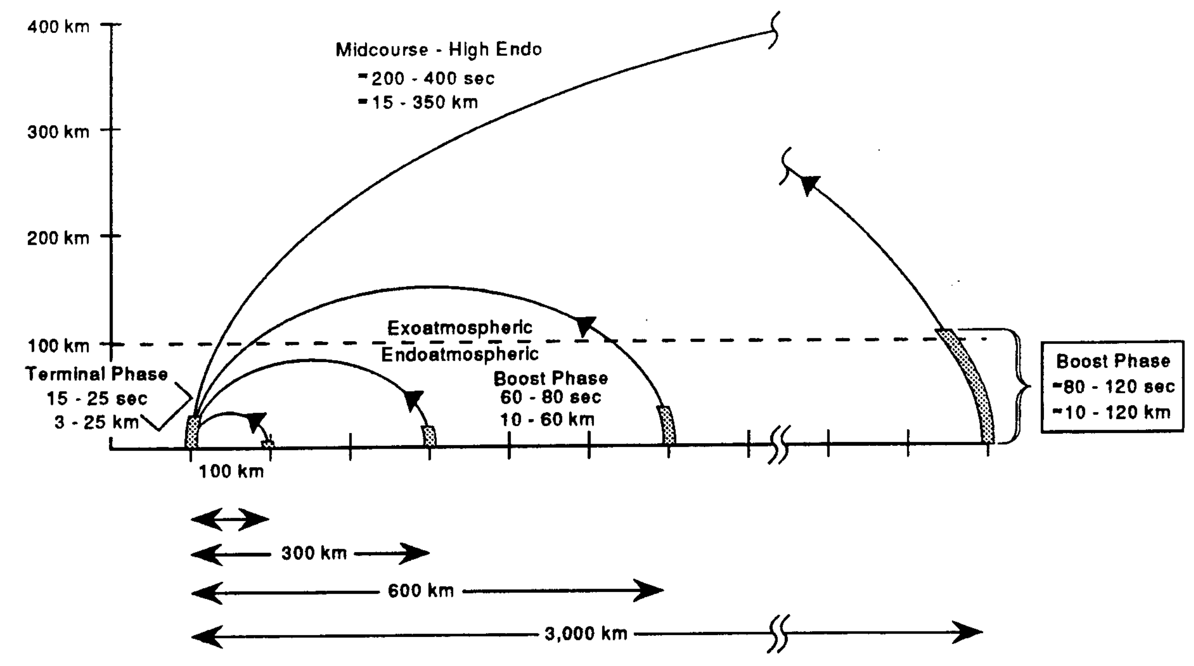
1) Counterforce is not a substitute for active defense, but is an important complement to it.

2) Destroying TBMs, especially those with weapons of mass destruction, through counterforce actions is desirable.

3) Counterforce can ease the active defense problem by containing and restraining enemy launch plans.

4) But, counterforce is not expected to achieve the attrition rates necessary to eliminate the requirements for active defense.

Active defense also has windows of opportunity relating to the different phases of a ballistic missile trajectory: boost and post-boost, midcourse, and terminal. (See Figure 2.1-2.) The boost phase refers to the early portion of missile flight when the missile booster engine is burning and thrusting the vehicle to burnout velocity; the post-boost phase refers to the period immediately after booster engine burnout (and, for a multiple warhead missile, initiates release of its warheads). The midcourse phase refers to the relatively long period when the warhead coasts along its ballistic trajectory. The terminal phase refers to the last portion of flight when the warhead enters the densest portion of the atmosphere.



2.1-2. Notional TBM Active Defense Engagement Opportunities

2.2 Active Defense Attributes

Based on the material of Chapter 1 and with heavy dependence on the material in the JROC-validated TMD Mission Needs Statement and in the Service ORDs published to date, it is possible to describe those attributes which are necessary to achieve a TMD active defense capability. With the completion of Service documentation and JROC validation of requirements, that information -- or at least the unclassified portions thereof -- will be used to modify or augment the material which follows.

2.2.1 Operational Deployment

A TMD capability must be able to meet a wide range of scenario or contingency missions. Some missions may take place with a slow, deliberate buildup, as in Desert Shield, where air defense systems were transported initially by a combination of ship and aircraft, or hostilities may erupt with little or no warning where defenses will be limited to whatever forward deployed forces are immediately available. Other missions could require forced entry under hostile conditions where neither airlift or sealift would be possible, and defenses may be provided only from the sea. Future adversaries will no doubt take note of one of the lessons learned during Desert Storm: the U.S. should never be allowed the time to build up its full combat power. Designing TMD systems to be easily transportable by strategic and tactical

airlift and developing systems for deployment on naval combatant ships will therefore provide needed flexibility in moving defensive systems quickly into the theater environment where they will be employed.

Such capabilities permit rapid insertion by air or sea of augmenting expeditionary forces and the security needed to offload land-based TMD forces from airlift or from ships. Accordingly, land-based TMD systems must be air transportable in a variety of cargo aircraft to ensure the shortest possible arrival time based on varying demands for airlift priority. Likewise, TMD equipment could be loaded aboard maritime prepositioning ships to enable early movement to the crisis area where airlift could provide the personnel necessary to off-load, prepare and operate the equipment. The TMD systems themselves must be designed to require a minimum of ground support equipment, personnel, and support infrastructure to ensure rapid mobility and low-impact transportability.

More specifically, TMD systems must be

- **capable of quick and easy movement by air**
- **capable of forward deployment by ship in the crisis area**
- **available for rapid utilization after deployment**

2.2.2 Operational Employment

A wide range of operational employments and scenarios must be anticipated. For example, utilization of TMD could be to a mature theater such as Europe or the Pacific where TMD might be used in conjunction with allies and must fit into an existing command and control structure. Alternatively, the scenario might be a deployment to a contingency theater with little or no defense infrastructure. Lastly, the deployment might be a mobile bilateral support operation, as with the United Kingdom or Israel, or support to a cooperative nation or group.

Tactical employment of TMD capability will rely on flexibility in physical deployment of various system components in and around ports, airfields, expeditionary forces, cities and other vital assets. Employment schemes must be able to rapidly adjust to supplement existing forward deployed forces or to establish new defensive enclaves as the crisis unfolds. The ability to adjust defenses to protect new debarkation points and maneuvering forces is critical. The ability to quickly adjust intercept trajectories and reorient defended footprint geometries is essential. This requires adequate mobility for either sea-based or land-based TMD systems.

TMD forces must provide an extremely high level of operational availability. Systems may be required to conduct sustained operations for extensive periods of time. Manning and logistics support must take this into account. Inherent survivability features will be required in the event of operating in nuclear, biological and chemical environments.

Specifically, TMD systems must be

- **flexible to accommodate a wide range of operational employments (locations and scenarios)**
- **capable of tactical movement to support troops and mobile military assets on the battlefield**
- **able to achieve a high degree of availability and sustainability**
- **provided with inherent survivability features in a variety of nuclear, biological and chemical (NBC) environments.**

2.2.3 Operational Effectiveness

Early and accurate detection of TBM launches is necessary to enable alerting and cueing of the surveillance and fire control radars of active defense units. With short missile flight times, early detection is critical; performance of tracking radars can be increased if they are cued to search specific areas or volumes of space for incoming missiles. Timely launch detection and impact point prediction will provide warning to friendly forces and population centers, increasing the effectiveness of passive defense.

Extended surveillance range is highly desirable since it generally leads to increased intercept ranges and permits additional engagement opportunities on incoming missiles. This surveillance function must discriminate possible decoys, countermeasures, or other deceptive measures designed to make tracking and targeting of warheads more difficult.

Longer range intercepts are desirable since they permit additional intercept attempts (i.e., defense in depth) if the first intercept fails. Intercepting at long ranges and high altitudes, or over water if possible, is generally consistent with keeping the debris of the intercept away from the defended areas and targets (and potentially on the attacker's territory), especially in the case of weapons of mass destruction.

Close-in or asset defense of relatively small areas to include cities, debarkation ports, coastal airfields, and military installations is necessary. Also, the priority with which certain assets need to be defended may vary with time, as in the case of harbors or ports used for disembarking troops and supplies at the beginning of an operation. This leads to a requirement for a preferential defense capability.

When there are multiple asset points requiring defense within a geographical area, individual asset defense capabilities would be expensive and probably very inefficient. Area defense capabilities of approximately 100 km in radius are indicated.

Leakage is the major measure of the success of TMD since it relates to the number (or percent) of incoming TBMs that will penetrate the defense. Achieving every intercept and having the intercept result in destruction of the incoming warhead is the most desirable. Although 100% intercept success is unlikely, a 90% intercept success rate (10%, leakage) is considered technologically achievable against a single target. With two independent systems

(such as an upper and lower tier --- see Chapter 3) closely coordinated, 99% attrition or 1% leakage could be expected over areas where coverage exists. Low leakage must be obtained against all types of attacks and against all types of warheads.

Specifically, TMD systems must

- **provide early and accurate launch detection and impact point prediction for civil and military units;**
- **provide extended surveillance ranges and altitudes;**
- **provide low leakage defense of assets and areas;**
- **provide a capability to preferentially defense certain areas or targets;**
- **be effective against a range of TBM threats and resistant to enemy countermeasures; and**
- **intercept missiles high enough to minimize effects from NBC debris.**

2.2.4 Operational Integration

TMD is only one facet of the many military operations that may take place during a theater conflict and, hence, TMD must integrate with these operations -- from the National Command Authority (NCA) and CINC level to other air offense and defense operations to friends and allies. The burden of this will fall on the C^3I systems. The command and control structure must be flexible enough to provide coordination from low-level crisis to large scale regional conflict and to cover various phases of an operation that may envision transition of joint air defense command from ships at sea to land-based command centers ashore. Further, since most crisis theaters will involve more than one nation's sovereign land and air space, TMD capabilities must consider the means to integrate various surveillance, tracking identification, and engagement systems. Due to the wide variety of capability and equipment in use worldwide, design flexibility and interoperability will be required on different levels.

TMD must work in conjunction with other theater defenses, as well as with offensive operations. For example, U.S.-Allied air strikes may be in progress when active missile defense is required. U.S. and allied aircraft may be transiting an area under missile attack. Defenses must be able to discriminate between friendly and enemy aircraft while simultaneously countering incoming TBMs. Integration of TMD with related theater mission areas is accomplished through the Theater Air Control System (TACS) under the command of the Joint Air Force Component Commander.

The defensive surveillance system must be integrated with theater air control. Information gathered from an incoming missile's trajectory can be used to locate its launch point, which can then be relayed to airborne, sea-based, or ground-based counterforce capabilities.

Desert Storm illustrated the benefits and difficulties of coordinated air, sea, space, ground, and amphibious operations. An effective theater missile defense must take advantage

of the strengths and assets of each Service, as well as those of participating allies. Communication systems must be interoperable at different levels of command in order to pass intelligence, launch detection, sensor cueing, and targeting information among the forces.

Multi-Service integration is essential; it is not difficult to envision a scenario wherein a missile launch is detected by a space asset, tracked by sea-based radar, and engaged by ground-based interceptors while the missile launcher is being destroyed by aircraft.

Specifically, TMD systems must integrate with

- **CINC and National Command Authority structure**
- **theater offensive operations**
- **theater air defense operations**
- **C^3I of allies or coalition partners, to the extent possible.**

* * *

Chapter 2 in Review

- ***TMD before missile launch is counterforce; after launch it is active defense. Each has several windows of opportunity.***
- ***Seventeen attributes for TMD active defense can be specified on the basis of the material in Chapter 1, especially from the pertinent Service and JROC-validated requirements. These can be grouped into four operational areas:***
    - ***deployment***
    - ***employment***
    - ***effectiveness***
    - ***integration***

Chapter 3

Active Defense Framework

Chapter 3

Active Defense Framework

This chapter uses the operational and technical attributes of Chapter 2 to formulate a framework of capabilities leading to a TMD active defense architecture. The selection of specific elements to achieve these capabilities is then discussed. Ten elements are identified; a presentation of the status and issues relating to these candidates is included in the Appendix.

3.1 Architectural Considerations

3.1.1 Early Capability

The TMDI architectural formulation and acquisition strategy are predicated on acquiring TMD active defense capabilities on an accelerated schedule while maintaining sound acquisition procedures with low-to-moderate risk and concurrency. The two main objectives in that regard are:

- **Provide the earliest capability by upgrading existing systems, leveraging on the substantial past investment in these systems and their infrastructure.** Existing air defense systems such as PATRIOT, HAWK, AEGIS, and the theater air command and control system can be upgraded to provide enhanced TMD capabilities. Prior investment in tactical warning and attack assessment systems can also be leveraged by making better use of data from early warning satellites to support TMD. These enhancements will be demonstrated and implemented as rapidly as possible.

- **Provide early limited capability by developing, fielding, and testing User Operational Evaluation Systems (UOES) as part of Dem/Val phase of the development process.** These UOES have two objectives: (1) testing, evaluation and training for a system proceeding through the normal acquisition process; and (2) contingency defense capability should the need arise prior to completion of the normal acquisition cycle. Expanded testing and training is important because of limited operational experience with ballistic missile defenses.

The land-based UOES planned at this time will consist of a THAAD/GBR battery made available as early as 1996 for contingency use. A possible sea-based UOES could consist of at least one AEGIS ship and 35 SM-2 Block IVA missiles available in 1997.

3.1.2. Architectural Tradeoffs

The overriding goal of TMDI is to achieve a robust and operationally effective and survivable defense capability with a minimum life cycle cost and a minimum number of development and acquisition activities.

A final or detailed ATBM system design can be reached neither quickly nor without comprehensive review. The approach adopted herein is to outline the broad architectural framework that incorporates the characteristics and attributes described earlier. (Note: Even this broad framework must be periodically reviewed in terms of desired attributes, available technical solutions, cost, and effectiveness.) Within this framework, specific elements and systems will be studied, selected, and acquired over time.

For example, a major decision relates to the tradeoff of early capability against the degree of risk involved in achieving that early capability. Equally important are the tradeoffs between robustness and effectiveness of the system versus the cost, including development, production, and operating costs. A very robust design with a minimum susceptibility or vulnerability to possible countermeasures can be very expensive. The difficult question is to ascertain when additional cost no longer brings major increments of robustness or effectiveness.

Freezing the detailed design of an element too early can deprive the defense system of the contribution of new technology. Freezing the design while potential enemies are proceeding to advanced countermeasures would not make sense. Likewise, continuing to introduce emerging technology may prevent stabilization of a design for early availability or for efficient production.

These issues, coupled with the multi-Service nature of the TMDI, place an extra burden on the management of the system and its architecture. TMDI management must be objective with respect to the capabilities and desires of the Services and knowledgeable with respect to potential solutions. These issues influence the management aspects of acquisition strategy discussed in Chapter 4.

3.2 Framework

Based on the operational and technical attributes of Chapter 2 and the other factors discussed above, a framework for the active defense pillar of TMD has been defined. This framework comprises five broad areas of capabilities that satisfy the required attributes:

1) A **mobile ground-based and ship-based lower tier** (terminal phase) intercept capability to defend limited area and point asset targets.

2) A **mobile ground- and ship-based upper tier** intercept capability with extended intercept envelopes to provide area defense and assure multiple intercept opportunities.

3) A potential capability for **boost or post-boost intercepts.**

4) Enhanced **warning and surveillance** capabilities for launch detection, extended and netted surveillance, and for cueing of the ground and sea-based weapon capabilities.

5) C^3I capabilities to manage those listed above and integrate them with other U.S. and allied systems.

The rationale for these elements can be addressed in terms of answers to the questions below. (See also Figure 3.2-1.)

	Lower Tier	Upper Tier	Boost Phase
Advantages	• Atmosphere Will Help Discriminate Penaids • Joint Capability With Air Defense • Additional Shot Opportunity For Reducing Leakage When Used With Upper Tier • Initial Capability Already Exists	• Ballistic Trajectory Eases Flight Path Prediction • Intercept High And At Long-range (Reduced Collateral Damage) • Less Stressing On Interceptor And Sensor • Allows Multitier Defense	• Large, Bright, Slow-moving Target • Target Destructs Overhead Enemy • Target Is Easier To Kill • Provides Additional Tier
Concerns	• Requires Precision, High-technology Intercept • Stressing On Sensor And Interceptor • Collateral Damage Received From Target Intercept Debris • Limited Engagement Time • Intentional / Unintentional Target Maneuvers • Target Breakup Can Create Confusion • Some Shot Opportunities May Be Below Keep Out Altitude	• Penaids Possible • Aim Point Selection On Extended, Tumbling Targets • Kill Assessment	• Requires Special And Significant Sensor Capability • Short Time Line Requires Interceptor Over Enemy Or Weapon Capable Of Long Reach Quickly • May Require Special C^3 Capabilities

3.2-1 Active Defense Opportunities

Why an Upper Tier?

1) An upper tier provides the capability to engage missiles at long range and high altitude, resulting in a very large defended area footprint.

2) High altitude and long-range intercepts should minimize collateral intercept damage on the ground.

3) Longer range intercepts provide for multiple intercept opportunities (as in shoot-look-shoot) by the upper tier or in combination with the lower tier and should lead to lower leakage.

4) The larger footprint provides better flexibility of deployments and potentially less expensive area defense.

5) Intercepts before the missiles reach the atmosphere remove potential lower-tier maneuvering.

__Given an Upper Tier, why a Lower Tier?__

Given an upper tier, such as THAAD, the need for a lower tier may not be readily apparent. Factors supporting a lower tier requirement are as follows:

1) The lower tier is needed to intercept short-range low altitude TBMs which can underfly the upper tier. These short-range missiles represent a significant percentage of the current TBM threat inventory.

2) A lower tier using different phenomenology (radar frequencies, types of seekers, kill mechanisms) than the upper tier provides a significant increment of robustness.

3) A lower tier will provide extremely high protection for very important civilian and military assets.

4) The atmosphere will help in the discrimination of most decoys and countermeasures.

5) A lower tier can provide for the defense of the upper tier against attack by manned or unmanned air vehicles.

6) A lower tier already exists in the form of PATRIOT PAC-2. There is a very heavy (over $14B) investment in PATRIOT which also has an air defense capability against cruise missiles and the air breathing threat. With relatively small additional investments in PATRIOT, a significantly improved TMD capability can be obtained. A similar situation exists with the Navy where over $40B has been invested in the fleet of AEGIS cruisers and destroyers to obtain a powerful air defense capability.

__Why Sea-Based TMD Capability?__

Three separate studies during 1991 -- by the Defense Science Board (DSB), by the Naval Research Advisory Committee, and a study chartered by the Assistant Secretary of the Navy for R&D and directed by MIT Lincoln Laboratory -- concluded that the Navy had a substantial role to play in TMD active defense based on the following general rationale:

1) Ballistic missile protection will be essential in future regional contingencies.

2) Naval forces may be the only assets available in certain geographic locations or political scenarios. They can provide protection of debarkation ports and coastal airfields during theater insertion of land-based TMD assets.

3) Naval forces may be essential for forced entry in the theater.

4) Sea-basing costs are relatively attractive due to the large AEGIS fleet and its supporting infrastructure.

5) A viable multi-tier capability can be achieved fairly quickly.

6) Addition of sea-basing provides enhanced TMD robustness through geometry and frequency diversity.

Naval forces can arrive early in a crisis and remain on station for extended periods of time to deter a threatened TBM attack. Ships are inherently mobile and, as a result, can influence a wide area; they provide a high level of survivability and self-protection. Naval forces are ideal for employment where the U.S. has no forward-deployed forces or where the U.S. has decided to avoid the liabilities and uncertainties of foreign bases ashore. While ships at sea are much less vulnerable to TBM attack than fixed targets today, the potential for terminal guidance capability and increased accuracy, coupled with continued proliferation of NBC capability weapons, may provide a threat of limited effectiveness against ships in the future. The size and effectiveness of the defended area ashore will depend in part on the ability of naval forces to operate continuously in waters contiguous to defended forces.

While many potential contingency operations are expected to occur adjacent to the sea, there are still some which would be inland and beyond range of naval TBM defenses. Consequently, naval TBM forces will not obviate the need for land-based TMD active defense forces.

Why Boost Phase Intercept?

BPI is a potentially important addition to the TMD active defense architecture for the following reasons:

1) In the Gulf War, Scud debris as well as PATRIOT debris fell on friendly territory, sometimes inflicting damage. By intercepting TBMs in the boost phase prior to burnout, debris will fall short of the intended target. If the intercept occurs early enough, the debris or fallout will descend on enemy territory. This is particularly important if the warhead is a weapon of mass destruction.

2) A boost phase tier would expand the battle space and offer additional thinning of the attack.

3) A boost phase tier would offer additional protection against warheads that contain multiple elements (sub-munitions). By successfully attacking a threat missile before these munitions can be dispersed, it is possible to negate this threat and to discourage the use of this threat, particularly if the debris would fall on enemy territory.

4) A BPI has the potential to negate a wide range of penetration aids, since these devices would not have been deployed prior to intercept. BPI is one very effective way of addressing the discrimination issues introduced by penetration aids on the more sophisticated threats.

As noted in Figure 3.2-1, there are pros and cons to BPI. In general, boosting TBMs are very hot and are moving more slowly than after burnout. A boosting missile is more likely to be vulnerable to conventional defensive warheads, allowing the use of non-hit-to-kill interceptors;

however, the time lines in boost-phase intercept are extremely stressing. The boost phase lasts for a very short period -- 80 seconds or less, and a cloud cover could mask a missile launch for tens of seconds. This requires: a) exposure of aircraft as they loiter over or near enemy territory awaiting a launch; and b) special sensors and weapons to engage the threat.

Why tactical processing of launch detection data?

Current processing of DSP and other launch detection data processing capabilities as used in Operation Desert Storm was designed for strategic mission parameters (large, long-burn boosters; long flight times; ultra-low false alarm rates; etc.) and has several limitations in TMD environments (small, short-burn boosters; short flight times; higher acceptable false alarm rates). Tactical processing of launch detection data will reduce these limitations and provide a unique, early capability for robust continuous global launch detection. This new tactical capability will provide early warning and improved impact point estimates for passive defense; booster tracking to cue active defense systems; and, improved launch point determination for directing counterforce strikes. All this data will be provided rapidly to users over dedicated tactical data links.

3.3 Elements

There are a number of systems or elements under development or consideration today to meet the required capabilities of the above framework. These elements are listed below with a short statement of their status. A short summary of each is given in the Appendix. It is to be noted that these elements are in various stages of design, development, or acquisition. Some are major defense acquisition programs under the formal acquisition process and cognizance of the DAB, some are upgrades of existing capabilities, and some are in early conceptual definition.

These elements are:

PATRIOT

- PATRIOT's existing TMD capabilities are currently being upgraded through a material change process to incorporate near-term improvements to the radar and PAC-2 missile system. A major system upgrade (Milestone IV decision) to PATRIOT PAC-3 capability, including further radar upgrades and a new missile, is planned for the fourth quarter FY 93.

TPS-59 Radar and HAWK

- Improvements are being made to the TPS-59 radar and HAWK weapons system to provide some TMD capability. The effort is jointly funded with the Marine Corps.

Corps Surface-to-Air Missile

- Corps SAM is in concept definition with a potential initial operational capability after the year 2000.

AEGIS/SM-2 Block IVA

- AEGIS weapon system and radar software modifications are in engineering development. Changes to the SM-2 Block IV missile to achieve a PAC-3-like capability are currently in the design phase.

THAAD and TMD-GBR

- The THAAD system, including TMD-GBR, is currently in the Dem/Val phase with initial fight tests of the THAAD missile planned for the fourth quarter FY 94, and initial system tests planned to being in the fourth quarter FY 95. The Dem/Val phase is expected to lead to a UOES capability in late FY 96, and a Milestone II decision in the fourth quarter FY 96 to continue the program into engineering and manufacturing development (EMD).

Sea-Based Theater Capability

- The sea-based theater defense program will commence concept definition after a Milestone 0 decision scheduled in July 1993. A 15-month COEA will commence in early 1993, leading to a Milestone I in 1995.

Boost Phase Intercept

- A BPI study is in the data gathering/concept formulation phase to assess the options, including kinetic kill vehicles and airborne lasers, available in the near-, mid-, and long-term to intercept TBMs in the boost phase. The study will publish a final report in July 1993.

Launch Detection

- TMD launch detection programs are modifications to existing launch detection data (DSP and other) processing capabilities. While stereo DSP processing capabilities will be tested and exercised throughout FY 93, the next significant milestone will be demonstration of the first real-time multi-satellite fusion of DSP and other launch detection data in the fourth quarter FY 93 on the Talon Shield program. The follow-on early warning system (FEWS), an Air Force-funded program, is scheduled to replace DSP beyond FY 2000. It will be designed for the tactical threat and will process better sensitivity and quicker target update than DSP.

Brilliant Eyes

- Brilliant Eyes, jointly funded by TMD and NMD and hence an element of both systems, is in the Dem/Val phase with four satellites (two from each contractor) scheduled for launch in the first quarter FY 97. The program will enter the EMD phase in the second quarter FY 98 leading to an initial capability beyond FY 2000.

Command, Control, Communications and Intelligence

- The TMD C^3I builds on existing weapon systems, enhancing their performance with off-the-shelf technology. Improvements include: standardization of TMD messages; expanded use of TIBS, TRAP, and

JTIDS; upgrades to the Air Force CRC; and development of an Army ADTOC.

The relationships of these elements to the framework is given in Figure 3.3-1.

Capabilities		Candidate Elements
Lower Tier Intercept	Ground-based	PATRIOT, HAWK, Corps SAM
	Sea-based	AEGIS With SM-2 Block IVA
Upper Tier Intercept	Ground-based	THAAD, TMD-GBR
	Sea-based	LEAP, THAAD, Other
Boost Phase Intercept		Various Platforms And Weapons
Warning And Surveillance		Launch Detection, BE, TPS-59
Command, Control, Communications, Intelligence		Message Standards, JTIDS, TRAP / TIBS, ADTOC, MCE Upgrades

3.3-1. TMDI Capabilities Framework

It should not be assumed that all of these elements will be selected as part of the architecture. It is imperative to narrow down and select a subset of these elements. Affordability and cost-effectiveness will be the key factors in the down selection and will be imposed on all candidate elements. (Additionally there are some ABM Treaty considerations.)

3.4 Milestones

Key near-term activities in the TMDI active defense architectural efforts are currently planned as follows:

- completion and JROC validation of requirements documentation is expected to be completed during FY 93;
- an assessment of the next steps in achieving a BPI capability will be made in FY 93 following completion of the current BPI study; and
- selection of elements in the surveillance and warning, and the C^3I capability

areas should be largely completed in FY 94.

The above schedule would then permit compilation of reasonably accurate force structure estimates and life cycle costs in FY 95.

3.5 Capabilities by Time Periods

Three time periods have been selected to provide a time-phased reference for possible improvements to TMD capabilities. (See Figure 3.5.1.)

Capabilities		Near-term FY 93 - 95	Mid-term FY 96 - 99	Far-term FY 2000+
Lower Tier Intercept	Ground-based	• PATRIOT PAC-2 Upgrades • HAWK (USMC)	• PATRIOT PAC-3	• Corps SAM
	Sea-based	——	• AEGIS SM-2 Block IV A • SPY-1 Mod	——
Upper Tier Intercept	Ground-based	——	• THAAD (UOES) And • TMD-GBR (UOES)	• THAAD (Objective) • TMD-GBR (Objective)
	Sea-based	——	——	• Sea-based TMD Interceptor • SPY 1 Upgrade
Boost Phase Intercept		——	• Airborne Laser Prototype	• BPI (Objective)
Warning And Surveillance		• TPS-59 • Tactical DSP Processing	——	• Brilliant Eyes
Command, Control, Communications, Intelligence		• Launch Detection, Data Dissemination • Standardized Interfaces	• AEGIS BM / C^3 Mod • Surveillance Data Netting • Communication Upgrades	• Theater Command Center Modifications • AEGIS BM / C^3 Upgrades • Cooperative Engagement

3.5-1. TMDI Active Defense Candidate Capabilities

In the near-term (FY 93-95), upgrades to PATRIOT PAC-2 and missile defense capabilities of the Marine Corps are programmed. Improved tactical processing and dissemination of DSP launch data is already underway.

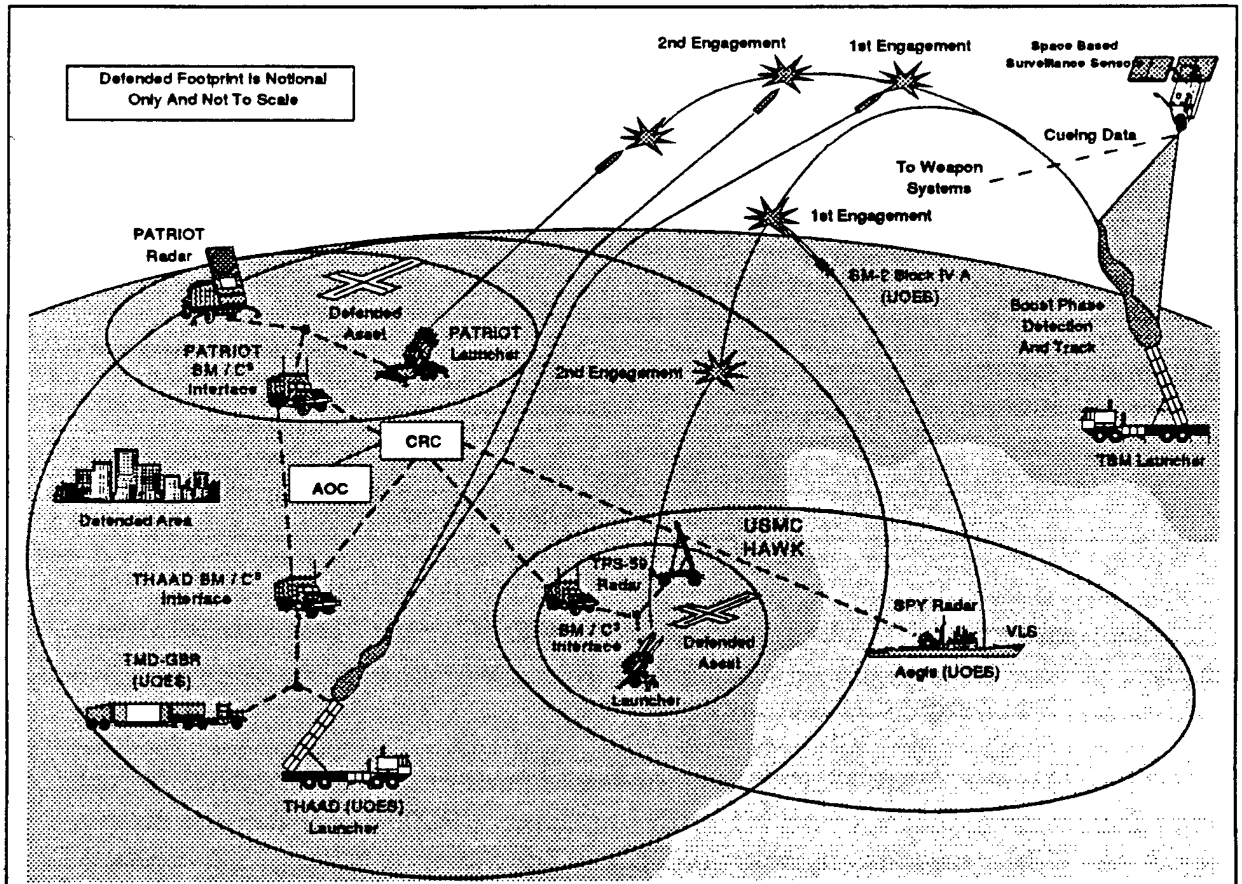
In the mid-term (FY 96-99), PAC-3 upgrades will further improve the PATRIOT system. This may include enhancements from the ERINT program or PATRIOT multimode missile. A sea-based PAC-3-like capability utilizing AEGIS and the Navy's existing SM-2 Block IV missile to defend debarkation ports, coastal airfields, amphibious objective areas, and expeditionary forces as they are inserted ashore could be added. Subsequently, a sea-based

capability TMD utilizing a longer-range missile could become available as a UOES and could provide extended theater-wide footprints.

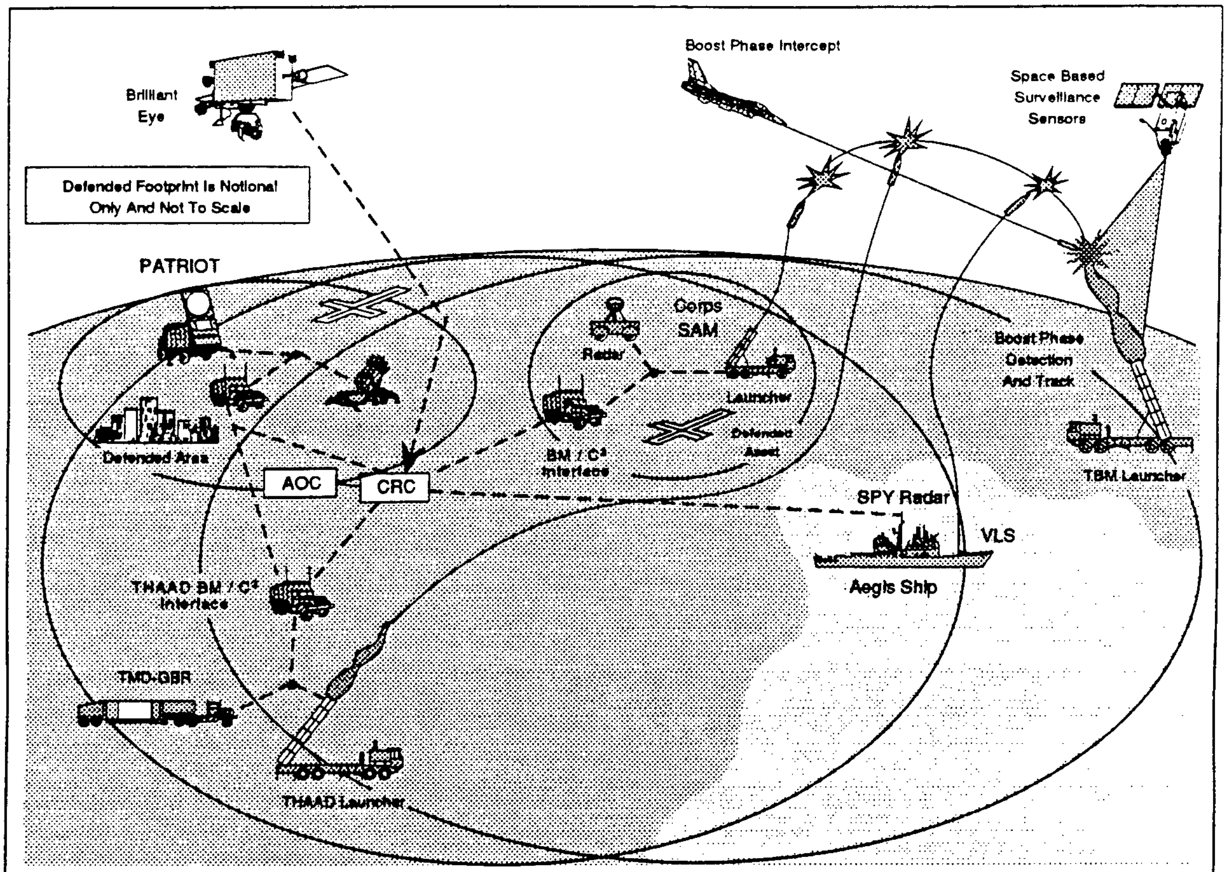
Also in the mid-term, and to move beyond the inherent limitations of a point or limited area defense system, wide area defensive coverage using the THAAD interceptor system, including the TMD-GBR, will be added. To respond to the Missile Defense Act mandate for fielding an advanced TMD capability, the option for a prototype THAAD "battery" or UOES at the end of the Dem/Val phase in 1996 for early operational assessment and possible deployment if a contingency requirement arises is provided. ***Provision of the UOES is a major current thrust and priority of the TMDI.***

In the far-term (FY 2000+), the availability of Brilliant Eyes (the space-based sensor) could enhance the coverage of theater missile defenses by extending the range of THAAD and Navy interceptors by providing accurate midcourse cueing. Additionally, TMD capabilities could be added to the architecture in the form of the short-range Corps SAM and boost phase interceptors.

These ***planned or potential*** capabilities are graphically depicted in Figures 3.5-2 and 3.5-3.



3.5-2. Mid-term Active Defense System Architecture



3.5-3. Notional Far-term Theater Missile Defense Architecture

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Chapter 3 in Review

- ***Two major architecture objectives are to:***
  - ***provide earliest capability by upgrading existing systems***
  - ***provide an early advanced capability through the UOES***
- ***A framework of five capability areas have been adopted for the TMD architecture:***
  - ***upper tier***
  - ***lower tier***
  - ***boost phase intercept***
  - ***warning and surveillance***
  - ***command, control, communications and intelligence***
- ***Selection of elements for this framework is proceeding; the effort is to review and select the necessary subset of these elements.***

Chapter 4

Acquisition Strategy and Management

Chapter 4
Acquisition Strategy and Management

This chapter discusses several important aspects of the TMDI acquisition strategy for active defense. Neither this chapter nor this document is presented as a ***master plan*** or as a complete acquisition plan, although future iterations of this document will support information on several topics not currently addressed (e.g., technology transfer and technical support). The chapter concludes with the plans for near-term experiments and demonstrations.

4.1 Approach and Priorities

The fundamental concepts of the acquisition strategy -- upgrading of existing capabilities and an early limited capability increment by UOES -- were presented in Chapter 3.

Additional tenets of the acquisition strategy are briefly stated as:

- proceed with low-to-moderate concurrency and risk
- leverage BMDO technology to the maximum possible extent
- demonstrate and exercise capability enhancements as rapidly as possible.

As regards operational priorities:

- Improve the ground- and sea-based lower tier (terminal phase) capability through modifications to PATRIOT and AEGIS
- Add a second or upper tier in the midcourse phase as soon as possible, with a UOES available in 1996
- Explore possibilities for boost phase intercept capabilities as soon as technologically feasible
- Improve the launch detection aspects of surveillance and warning as soon as possible
- Integrate multi-Service systems as soon as possible.

4.2 TMD As A System

TMD active defense involves a number of different functional capabilities: detection of a launch, surveillance and warning, weapons launch decision, tracking and discrimination of incoming warheads, interceptor weapons guidance, handover of the end-game engagement to

the interceptor, kill assessment, and additional engagement decisions. Multiple elements, subsystems, and systems are involved. Several Services and allies may be involved.

Thus, TMD active defense is a complex process. It is made more complex by the need to handle an increasingly diverse and challenging set of threats, the desirability of having multiple tier defenses comprised of upper and lower tier capabilities (and, perhaps, boost phase) to achieve defense in depth, and the need to operate in a variety of environments and scenarios.

In short, **TMD is not a simple system.** TMD active defense must integrate and coordinate its launch detection, surveillance and warning, C^3I, and other functions with the strategic defense system and other national systems. Some of these other systems have non-ATBM functions. TMD is also not a totally new system, but builds on existing capabilities and must work within the existing Theater CINC-Joint Task Force (JTF) air defense structure. These multiple-system/multiple-Service characteristics influence the management structure and approach to be used in the TMDI acquisition strategy.

4.3 TMD Responsibilities

As noted, the FY 93 Defense Authorization Act directed the Secretary of Defense to establish a TMDI office to coordinate all theater and tactical missile defense activities of DoD. The Act indicated that it was not intended to rule out any arrangement which the Secretary of Defense deemed most appropriate, including placing it under management and direction of the Director of SDIO.

In January 1993, the Secretary of Defense assigned management and direction of the TMDI to the Director of SDIO. The primary reason for common SDIO management is the coordination of operational requirements and the efficiency of central technical development of missile defense activities, since technical challenges facing ballistic missile defense sensor and weapon systems have many common aspects, irrespective of the tactical or strategic mission. For example, interceptor functions such as guidance, propulsion, and target kill are common to all interceptors and can be supported by common technology efforts.

The "family of radars" is an example of the benefits of a SDIO/BMDO-initiated joint development program. The family of radars will use a single X-band development program as the basis for designing and producing separate radars for the TMD and NMD. Substantial savings result from the single development and testing effort. Another potential area of cost saving and technology efficiency is the future infusion of pre-planned product improvements (P3I) into the TMD and NMD programs. All missile defense systems must plan for improvements so that they can enhance their performance capabilities and react to changes in the threat (such as countermeasures). BMDO will ensure better focus and efficient introduction of major upgrades since it will direct these P3I and system development efforts for TMD and NMD elements.

A second reason for central management is the critical need to ensure that all ballistic missile defense systems will be interoperable. NMD and TMD elements, along with other

national systems, may be forced to cooperate in certain threat scenarios. Strong central acquisition management is the best way to ensure that interoperability of ballistic missile defense elements under development are considered at the requirements stage and are included in the subsequent system designs.

Based on this decision, the responsibilities within DoD for TMDI are summarized in the following points:

- The Secretary of Defense and Under Secretary of Defense for Acquisition and Technology provide overall policy, program, and fiscal guidance to the Director, BMDO.
- OSD will develop and ensure implementation of TMD policy guidance, including DoD activities related to allied involvement in TMD; conduct program reviews as appropriate to assure evaluation of competing technologies and programs in active and passive defense, attack operations, and C^3I related to TMD; conduct treaty compliance reviews of TMD programs; review TMD test and evaluation activities; and, assure that the acquisition process complies with DoD Directive 5000.1 and Instruction 5000.2.
- The JCS, in conjunction with the CINCs, will formulate the operational concepts; coordinate and validate mission needs and operational requirements; provide liaison with associated Allied Commands; establish command and operational control doctrines for resources assigned; and, establish command relationships, force structures and assets, protocols, and rules of engagement.
- Theater/Specified CINCs will identify TMD requirements in their theater of responsibility; provide liaison with associated Allied Commands; establish command and operational control doctrines for resources assigned; and, establish command relationships, force structures and assets, operational plans and requirements, protocols, and rules of engagement.

An MOA between BMDO and the Services outlines the relationships with respect to theater and strategic ballistic missile defense acquisition. From the General Manager, funding and guidance (Program Management Directives or PMDs) flow to the Services and the Service Program Managers (PMs).

The BMDO AGM for Theater Defense is the central TMD manager and provides direction for the TMDI program. The AGM for Theater Defense is responsible for:

- central TMDI management for DoD
- defining the TMDI system architecture and design
- integrating requirements and technology
- developing budgets and allocating resources

- ensuring integration with other U.S. and with international defense capabilities
- TMDI system integration
- coordinating TMDI with NMD.

As individual programs reach production and an initial operating capability (IOC), the point of transfer of programs to the Services, including associated resource considerations, will be approved by the Defense Acquisition Executive (DAE). The AGM for Theater Defense will ensure that Service technology requirements are clearly defined so that funding and development are executed in a timely manner.

The Services play a key acquisition role throughout the TMDI program, contributing to program management decisions, technology selection, test and demonstration programs, and maintaining program viability. Specific Service roles and missions in the TMDI program are to perform the following:

- develop operational requirements
- manage TMDI programs under BMDO direction
- provide program analysis and support
- participate in the conduct of development, test and evaluation (DT&E)
- conduct operational test and evaluation (OT&E)
- support production, deployment, and operation of assigned TMDI systems as required and agreed upon
- plan for and fund programs after their transition to the Service responsibility including training, operation and support.

In addition to their role in supporting the TMDI program, the Services are responsible for the other facets of TMD outside the scope of TMDI, including defense against theater cruise and air-to-surface missiles and the other TMD pillars of counterforce, passive defense, and C^3I efforts not covered under TMDI. Specific Service roles and missions outside the scope of TMDI are:

- develop operational requirements for Service TMD systems
- fund and manage Service TMD acquisition programs, along with supporting technology efforts
- perform concept studies and conduct modeling and simulation activities for Service TMD projects
- conduct DT&E of Service TMD programs
- conduct OT&E of Service TMD programs
- produce, deploy, operate, and support Service TMD systems

- train, organize, and equip Service component forces to perform TMD missions in support of war fighting CINCs
- integrate the Service TMD activities with other related Service mission areas, such as air defense, counter-air and offensive air operation.

Within BMDO, the AGM for Theater Defense reports directly to the General Manager, who reports to the Director BMDO. The AGM for Theater Defense receives staff support from the BMDO staff units and interfaces with the other line deputates as follows:

1) The Deputy for Technology provides technology support, including management of the LEAP technology development program.

2) The AGM for Strategic Defense manages the development of a larger version of the TMD-GBR radar, which is intended for strategic defense. This deputate also leads and directs the development of Brilliant Eyes.

3) GM staff elements provide overall test support, including management of a program that provides the necessary targets for all TMD tests, and the planning for formal test and evaluation operation.

4) The Deputy for Program Operations is responsible for all financial and programmatic aspects of BMDO operations.

5) The Deputy for Strategic Relations facilitates allied participation and cooperation in BMDO international efforts. This deputate also conducts certain studies and analyses and provides guidance on public and legislative affairs activities.

4.4 Test and Evaluation

Documentation on TMD test and evaluation is currently in preparation; it will be published in one or more test and evaluation master plans (TEMP). This section summarizes material being prepared.

4.4.1 Test Planning

The phased acquisition of TMDI, coupled with its inherent complexity and size, will require extensive reliance on system models of varying fidelity to establish and evaluate technical issues and to perform integration and interoperability testing. Element-specific flight tests including propulsion, guidance, and one-on-one intercept tests, as well as multiple interceptor/target flight tests and integrated system flight tests, will be required. Integrated simulation and ground testing will supplement flight testing to validate element performance

and interoperability performance and support resolution of critical issues. Finally, overall system testing and exercising will be required.

Simulations, models, and test beds for each TMDI element are specified in the TMD element TEMPs. Elements will make use of existing facilities developed and funded by BMDO and the Services, including the National Test Facility (NTF) at Falcon AFB and the distributed National Test Bed (NTB). Element-unique models and simulations used for testing will be developed to support Dem/Val, DT&E, and OT&E as required. They will serve to expand the current BMDO test facility base. Test beds (see Figure 4.4.1) and simulations are resources that will provide a baseline for evaluating segment-related integration issues.

The TMDI test program will be integrated among the Services and will build on existing BMDO and Service programs. TMDI-specific programs will be coordinated to ensure that:

- Service operational requirements are clearly defined
- The use of existing technology efforts is maximized
- The program focus on validated threats is maintained
- Priorities and schedules are synchronized
- Testing already accomplished at Service level is not duplicated
- Interoperability exists between the TMDI and the NTB resources.

Name	Characteristics				
	Elements	Operators	Comm.	Targets	Interceptor
Totally Simulated (EADSIM)	S	S	S	S	S
CPX (e.g., Questor Grail)	S	L	L	S	S
System Exercise	L	L	L	S	S
Live Demonstration	L	L	L	L And S	L And S
S = Simulated L = Live Or Real					

4.4-1. Possible Levels Of System Exercises

Formal test and evaluation (T&E) will be performed by the developing Service for each TMDI element program. The DT&E activity will be conducted by an agency (normally under the direction of the Program Manager) designated by the Service Acquisition Executive. OT&E will be conducted by each Service under the direction of dedicated, independent OT&E agencies.

4.4.2 Theater Test Beds

TMDI sponsors the development and use of several test beds as a means of providing common analysis tools to support resolution of TMD and extended air defense (EAD - a term used to include air defense and an extended mission of theater missile defense) issues such as:

- theater level system requirements, architectures, force structures, and operational concepts;
- doctrine and battle planning;
- mix and interaction of various weapon systems;
- system integration, interoperability and interfaces;
- technology applications to systems and concepts; and
- war gaming, live exercise preparation and evaluation and training.

The Theater Test Bed Program provides a user friendly, computer-based simulation analysis capability for multi-Service and multi-national use. All elements and functions of TMD will be modeled at varying levels of fidelity. The Test Beds will be capable of analyzing theater-level scenarios and will permit evaluation of the effects of hardware capabilities, operational concepts and system architectures. The man-in-the-loop (MIL) capabilities will provide the user with a real-time, flexible capability to analyze existing and future battle management and command and control concepts. The Theater Test Bed program consists of four separate test bed development activities: a low to medium simulation capability. Extended Air Defense Simulation (EADSIM); the Extended Air Defense Test Bed (EADTB), the Israeli Test Bed (ITB) and the United Kingdom Test Bed (UKTB). In addition, the Theater Test Bed activity for TMDI will be fully interoperable with the NTF and Advanced Research Center (ARC) environment to allow both theater and strategic integrated ground, sea, air, and space capability evaluations for theater CINCs.

EADSIM is a two-sided, theater level simulation capability which can be hosted on any Silicon Graphics work station. It supports extended air defense analysis with emphasis on C^3I. EADSIM is used by BMDO, the three Services and several allies and friends.

EADTB will consist of computer-based simulations and the supporting software and hardware necessary to conduct analyses supporting a variety of EAD issues. EADTB will include a common software environment consisting of threat, environment, weapon and sensor modules, and associated C^3I modules. EADTB will provide a real-time MIL and HWIL capability for experiments of existing and consolidated command and control (C2) equipment.

The **UKTB** is a jointly-funded (U.S. 53%, U.K. 47%) activity with the U.K. Ministry of Defense that involves enhancing the existing U.K. Air Defense Test Bed. The software tool SIMBOX is being redesigned in Ada and enhanced for TMD application. This highly object-oriented approach will allow for the highly detailed modeling of any elements in the U.K. TMD Architecture.

The **ITB** Program has developed a complex test bed in Ada that achieved an operational status in March 1992. A jointly-funded (U.S. 70%, Israel 30%) experiments program with the Israeli MoD is currently analyzing Israeli missile defense requirements and architecture concepts against a variety of threats and missions.

4.4.3 System Test and Exercising

As TMDI moves forward toward a deployable TMD active defense contingency capability by late 1996, consisting of a number of existing, upgraded, and new elements acquired by different Services, there will be a need to conduct system-level exercises for purposes of:

- integration and checkout;
- performance measurements under a wide variety of situations and environments;
- validation of capability and readiness; and
- training of personnel.

The expected extent and scope of such system level exercises dictate that this cannot be done exclusively with live targets and live interceptors. Thus, a capability is required to exercise as realistically as possible the actual system elements with simulated targets and simulated interceptors. The use of the NTB to provide integrated system exercising and testing is now under active consideration.

System level exercises would follow appropriate element testing, both simulated and live. (See Figure 4.4-1.) The element testing would culminate with a level of testing of element pairs and of interfaces.

4.4.4 CINC Exercises

Another aspect of the TMD test and evaluation process are those efforts already underway to help the CINCs prepare for future TMD capabilities and explore their unique problems and interfaces. This is done by a series of exercises conducted by the CINCs with TMDI financial and technical support.

Although the Army has the lead, these exercises are designed and executed in a joint theater environment. In conjunction with major theater exercises and working with the exercise designers, events relating to simulated TBM attacks are programmed into scenarios. During the actual exercise, appropriate information is provided to the players to allow for active defense, counterforce and appropriate passive defense activities. Interest and participation by theater commanders and their staffs have significantly increased over the past few years. The actual system used to support CENTCOM during Desert Shield and Desert Storm was devised utilizing the experience gained from the exercises that preceded Questor Grail. These exercises

allow, among other enhancements, incorporation of national systems capability into exercise play, all designed to improve the theater commander's understanding of TBMs and appropriate counter actions.

These exercises cover all four pillars of TMD as well as the inclusion of various warning and intelligence sources. Exercises have been conducted in the past with EUCOM; future plans include PACOM and CENTCOM, as indicated below. SPACECOM provides a supporting role in many of these exercises.

ORGANIZATION	TIMEFRAME	EVENT
CINCEUR	FY 89	Quiet Sunset
CINCEUR	FY 90, 91	Torpid Shadow I & II
CINCEUR	FY 92	Questor Grail
CINCPAC	FY 93	Ornate Impact
CINCEUR	FY 93	Optic Needle
CINCCENT	FY 93	TBD

* * *

Chapter 4 in Review

- ***TMD is a collection of elements and systems that must be carefully integrated within itself as well as with other systems in a variety of possible operational environments.***

- ***The central TMD manager is the AGM for Theater Defense in BMDO; the Services are responsible for the acquisition of TMD elements and systems.***

- ***Preparation of test beds and planning for TMD test and evaluation are key elements of the TMDI acquisition strategy.***

- ***TMD aspects are being introduced into CINC exercises to help CINCs prepare for future TMD capabilities and explore their unique problems.***

Chapter 5

International Activities

Chapter 5
International Activities

5.1 Background and Goals

The goal of the TMDI is to develop ATBM systems to provide protection against existing and projected ballistic missile threats to deployed U.S. forces and our allies. This activity is being structured to meet U.S. needs, while taking into account that these systems should be interoperable with allied national or multinational missile defense forces. Thus the broader objective of the TMDI is to develop systems that are complementary and compatible with allied TMD systems.

Allies have participated in SDIO's strategic defense activities since 1985, in accordance with applicable U.S. laws, regulations, policies and international objectives. Due to the nature of the threat posed our allies, their primary interest has been TMD. This interest was heightened by Iraq's use of Scuds in the Gulf War. Sometimes forgotten was Libya's Scud attack against the Italian island of Lampudusa following the U.S. raid on Tripoli. North Korea's continued development and export of improved ballistic missiles has raised considerable concern in the Western Pacific region.

SDIO's, now BMDO's, international TMD program began with a series of architectural studies examining requirements for meeting threats to our allies. These studies included, at the beginning, both strategic and theater threats armed with nuclear, chemical, biological, and conventional warheads. Several studies were conducted by government-led teams, while others were performed by multinational contractor teams. Theaters examined included Europe, the Mideast and the Western Pacific regions, each with very different geography, political-military situations, and threats. These studies concluded, in general terms, that missile defenses are both required and technically feasible. Further, these studies have led to the identification of programs and activities relevant to TMD, e.g., the cooperative U.S. - Israel Arrow/ACES effort.

Follow-on cooperative TMD activities also have included sensor and lethality experiments and the design and development of theater test beds to evaluate TMD doctrine and technology.

5.2 Israeli Programs

Israel, in their earlier architecture studies, identified an architecture to defend their country against ballistic missile attack from the surrounding region. They are now acquiring the individual elements of that architecture, some in conjunction with the United States.

The primary cooperative programs with Israel have been the Arrow experiment and the follow-on ACES effort. In addition, smaller programs include an Israeli Test Bed, and system engineering and integration (SE&I) efforts. Congress has been a strong supporter of these efforts, frequently authorizing and appropriating specific funds for the work.

Separate MOAs were concluded for the Arrow experiment, ACES, and the joint U.S.-Israeli Test Bed experiment program. These MOAs defined the work to be done, cost sharing and terms and conditions of cooperation for the duration of each program. Each program has a different Israeli cost share depending on budgeting considerations and the relative benefits to the two partners with the majority of the program costs being borne by the U.S.

Arrow, which started in 1988, has been designed to meet Israeli architecture requirements for area defense of population centers against TBMs. The Arrow and ACES programs are technology demonstration programs. Under the Arrow program, four flights of the Arrow-1 missile tested the propulsion and interceptor subsystem integration. Each of the first three flights in the Arrow-1 program experienced some difficulty, and dictated delay of planned intercept tests to the ACES program; the fourth and last flight in the program occurred in the fourth quarter of FY 92 and generally achieved its mission objectives. Lessons learned in Arrow-1 flight tests will be used in the design of the smaller Arrow-2 interceptor, a prototype of a new missile building on Arrow-1 to meet the Israeli architecture requirements which will be used in the follow-on ACES phase.

The U.S. will use the results of the Arrow-1 and Arrow-2 test flights to reduce risk in U.S. developmental programs such as THAAD by taking advantage of critical flight data developed in the Arrow program. An important part of the ACES flight test program is the use of target vehicles with simulated chemical warheads -- a critical part of the TMDI lethality efforts. Additionally, the test flights of the Arrow-2 interceptor will provide a necessary basis for the Government of Israel to make important decisions concerning their development of a missile defense system based on the Arrow-2 design.

TMDI participation in Arrow and ACES represents a U.S. interest in the technology aspects of that missile technology demonstration program. The U.S. is not participating in the Israeli development of the required associated fire control radar in view of a lack of expected technology benefit to the U.S.

To help in the detailed evaluation and integration efforts for the Israeli missile defense system, the U.S. and Israel undertook a cooperative program to develop a TMD test bed in Israel. The Israeli Test Bed is now operational, and a series of experiments, studies and improvements are underway.

The U.S. and Israel are co-funding a SE&I effort which studies and evaluates aspects of candidate Israeli architectures. The current SE&I effort includes three major task areas: updating the definition of the threat to Israel and the TMD architecture changes needed to respond to that threat or other architectural enhancements; review of TMD-related Israeli development programs cooperatively funded with the U.S. for conformance with defense architecture requirements; and special studies and activities.

Finally, a small study is underway with Israel to examine the feasibility of a boost phase intercept system using high-altitude manned or unmanned aircraft which could complement the Arrow defense system.

5.3 Other Key Studies and Test Beds

The United Kingdom Architecture Study (UKAS) and the Western Pacific Architecture Study (WESTPAC) are two on-going TMD architecture studies These studies address a wide variety of architectural issues of interest to other sponsors: mission and operational requirements, critical technologies, effectiveness and life cycle cost analysis, basing system interface requirements, C^3I requirements, and development plans.

The UKAS is a study of the defense of Western Europe. The predominant scenario focuses on a limited threat: an attack on the U.K. by a Third World country or an accidental or unauthorized launch from forces of the former Soviet Union. The defense postulated in this study is ground-based and operates in the midcourse and terminal phases of the threat trajectory. The analysis includes the potential operation of U.K. forces in coordination with the space-based assets deployed by the U.S.

The scope of the UKAS effort beyond the end of the current contract is under discussion. This jointly-funded effort would focus on the U.K. missile defense requirements for the U.K. homeland as well as out-of-area operations. Architecture elements to be evaluated would include current U.S. TMD systems under development and the interoperability of these systems with the U.K. air defense structure.

There are two WESTPAC architecture analysis contracts with combined U.S./Japanese contractor teams. These studies, conducted with CINCPAC and BMDO assistance, address U.S. interests in defense of the Western Pacific region. The Government of Japan (GOJ) has not formally participated in these studies, but has reviewed the results of each phase of this program since its inception in 1988.

Under the WESTPAC contracts, which included four separate one-year phases, the teams have developed a complete threat and defense architecture for the Western Pacific region. Phase I provided a characterization of the conventional ballistic and cruise missile threats of all ranges and an architecture to counter those threats. Phase II evaluated and restructured the architecture to counter nuclear threat excursions, evaluated parametric variations in components of the architecture, and identified technology shortfalls. Phase III evaluated the emerging worldwide proliferation threat to the WESTPAC and developed contingency architecture designs to counter it. The final phase is deriving an architecture that addresses the requirements for WESTPAC tactical missile defense.

This defense architecture would be based on improvements to the Japanese Ground, Air, and Maritime Self Defense Forces supported by deployed U.S. forces, as available, to protect the Japanese Islands, the sea lines-of-communication across the Pacific, and other key military

assets in the region. The Japanese Defense Agency is now undertaking their own analysis of the evolving threat in the region.

NATO has recently initiated a number of extended air defense (or TMD) studies. A one-year study to address TMD issues in a NATO context is being accomplished under the auspices of the Advisory Group for Aerospace Research and Development (AGARD). A second activity in the NATO Research Study Group 16 on Command and Control is a three-year study of the TMD activities in the context of the NATO Air Command and Control System. BMDO is also negotiating an EADTB program with SHAPE Technical Center (STC) which will complement the NATO Research Study Group 16 efforts and other similar studies in the future.

* * *

Chapter 5 in Review

- ***International participation is an integral part of the TMDI.***
- ***A major development efforts -- Arrow/ACES -- is co-funded with Israel.***
- ***Studies of TMD in Western Europe, the U.K. and the Western Pacific are continuing.***
- ***Studies of TMD in NATO are being initiated.***

Chapter 6

Recent Progress; FY 93/94 Plans

Chapter 6
Recent Progress; FY 93/94 Plans

This chapter summarizes TMD progress in FY 92 and early FY 93 towards implementing the active defense architectural framework outlined in Chapter 3. Key TMDI goals and issues being addressed in FY 93 and FY 94 are presented. A program of near-term experiments and demonstrations is presented. Lastly, other key FY 93 issues and challenges are discussed.

6.1 Recent Progress

Significant TMD progress was achieved in FY 92 and early FY 93, providing support for the immediate upgrade of existing systems and rapid fielding of more capable systems. These key accomplishments are listed below.

ATBM Testing Moves Forward

The PATRIOT system successfully demonstrated a number of system upgrades funded under the Quick Response Program (QRP) to take advantage of lessons learned from Desert Storm. Notable among these were improvements to the PATRIOT radar, emplacement enhancements and remote launch capability. Additionally, the multimode seeker missile (a cooperative program with Germany funded with both Army and BMDO resources) made two successful test flights in 1992. The multimode seeker missile tests demonstrated improved capabilities against both air-breathing threats and TBMs. One remaining TBM intercept fight is scheduled for 1993.

The ERINT missile, currently being considered along with the multimode missile as a candidate for the PATRIOT PAC-3 missile, made two successful test flights in 1992. Both of these flights were controlled test flights; no intercept was attempted. In 1993, ERINT will be tested in intercepts of both air-breathing threats and TBMs.

The Arrow interceptor, a cooperative, cost-shared development effort between BMDO and Israel, had a successful test fight on September 23, 1992. Like the ERINT tests, this flight did not attempt to intercept a TBM. All missile dynamics and guidance controls were demonstrated as well as the proper functioning of the Arrow missile's seeker.

The first flight test of Phase 1 of the Arrow continuation Experiments (ACES) program, which involves four flight tests using the Arrow 1 missile, was completed on February 28, 1993. The flight test was an intended intercept of a surrogate tactical ballistic missile. The target was a TM-91 target vehicle designed for the Arrow and ACES program. The Arrow 1 interceptor

functioned well and achieved a small miss distance against the target. The flight test data is still being analyzed.

THAAD and TMD-GBR Milestone I Approval

The THAAD and TMD-GBR were approved to proceed past Milestone I, Concept Definition, in January 1992. Request For Proposals for the Dem/Val phase development for THAAD and the TMD-GBR were then issued in January 1992.

THAAD Contract Award

In September 1992, the Lockheed Missiles and Space Co. was awarded a $689 million four year contract for the development of the THAAD weapon system. Under the contract, Lockheed will build two truck-mounted launchers, two tactical operation center shelters, and 20 prototype missiles for demonstration and validation testing at White Sands Missile Range (WSMR) beginning in 1995. The contract provides for an $80 million option for 40 additional missiles to provide a contingency capability in the event of a national emergency.

THAAD Initial Design Review

A successful THAAD IDR was held in January 1993, and the program is preceding to Final Design Review in the first quarter FY 94. Prior to the IDR, government and prime contractor studies on THAAD deployment with the AEGIS Weapon System and the appropriate levels of nuclear hardening were accepted by the USD(A).

The contractor THAAD/AEGIS compatibility study indicated that a totally common Army/Navy THAAD missile would cause expensive modifications to the AEGIS Weapons System and would decrease missile performance. Therefore, if the Sea-Based TMD COEA, due in July 1994, indicates that a Navy THAAD variant missile to be the most cost effective option, DoD will maximize commonality at the subsystem level with the Army THAAD missile.

The contractor nuclear hardening study presented the cost, schedule and performance impacts of varying hardening options for the missile. A broader assessment of the appropriate hardening level for the overall TMD architecture has been initiated by the OSD staff. A final decision on the THAAD hardening level will be determined after an OSD study is completed in July 1993.

TMD-GBR Dem/Val Contract Award

A contract for $491 million was awarded to Raytheon in September 1992, to develop the "family" of ground-based radars, which includes the TMD-GBR as an integral component of the

THAAD system. The TMD-GBR will operate in the X-band mode with a reference range of greater than 500 km. TMB-GBR will also be transportable in a C-130. Two user operational evaluation system TMD-GBRs will be built under the contract to support testing at WSMR and provide the acquisition and fire control functions for THAAD UOES and also provide the cueing for the PATRIOT system.

Navy TBMD Program Definition

A new sea-based concept for ATBM capability has been defined and funded in BMDO's budget submission to the Secretary of Defense for FY 94 through FY 99. It establishes two programs: one based on AEGIS/SPY mods and improvements to the SM-2 Block IV missile; the other involving an interceptor (THAAD, LEAP, or some alternative) for a long-range theater-wide capability. They are described in detail in the Appendix.

Corps SAM Concept Definition Contract Award

In July 1992, six firms were awarded contracts to explore alternative concepts to identify the most promising solutions to protect mobile forces from low to medium altitude ballistic missiles, cruise missiles and all types of aircraft. Contracts of approximately $2.5 million each were awarded to Hughes, Martin Marietta, Lockheed, Raytheon, Loral-Vought and British Aerospace. These contractors will evaluate the entire Corps SAM system: missiles, sensors, battle management, support equipment and training. These concept definition studies are scheduled to lead to a Milestone I decision which may take one of three possible approaches: modification to an existing system, a new system with current technology, or a new system utilizing far-term technology.

Lethality Tests

Significant progress was made in FY 92 in the collection of data to establish baseline lethality data for kinetic energy (hit-to-kill) weapons against a broad range of TBM warheads. The TMD Lethality Technology program demonstrated that hit-to-kill interceptors are extremely lethal against a difficult threat (chemical sub-munition warheads) in a five sled test series at Holloman Air Force Base, New Mexico. Full-scale ERINT mockups were launched with a rocket sled at 2 km per second into stationary, simulated threat warheads (of one particular mid-size threat design). The sled tests proved that an ERINT hit-to-kill (or any larger hit-to-kill) vehicle can meet operational requirements when the expected performance envelope and hit-point accuracy of this interceptor can be achieved.

Tactical Surveillance Demonstration (TSD)

As a forerunner to the Talon Shield program, TSD provided the first real-time stereo processing of DSP data from live TBM-class targets in FY 92. This capability significantly improves all aspects of TBM early warning, including launch point estimation, impact point predictions, and trajectory estimation. Unlike Talon Shield, this project is focused on a deployable processor that would be transported into the theater and would process DSP data only. AEROJET is the prime contractor.

Talon Shield Contract Award

The Talon Shield program utilizes a CONUS-based, central processing facility to receive DSP and other space-based launch detection data, fuse and process the information, and provide it in near real time to the theater combat commanders. With improvements in the ground-based processor and utilization of multiple satellites, this system can significantly improve detection of launch locations and projection of warhead impact as well as provide cueing to TMD active defense elements. To support this effort, the Air Force awarded a contract to AEROJET Corporation in July 1992 for 36 months at a cost of $24.5 million. Talon Shield leverages the experience gained on the TSD and builds on it by also incorporating additional space-based data in its fusion process.

TPS-59 Upgrade Contract Award

A contract to upgrade the performance of the TPS-59 radar was awarded to General Electric in conjunction with parallel efforts by the USMC that will improve the HAWK missile and its interface with the JTIDS. When completed, this TPS-59 improvement program will provide low-cost TBM surveillance for HAWK, as well as cueing data through the Air Defense Command Post to other TMD elements. This will help provide the Marines with an organic capability to defend against TBMs.

TPS-75 Expert Missile Tracker

The Air Force sponsored a modification to the TPS-75 Air Surveillance Radar that successfully demonstrated real-time tracking of TBMs in tests at WSMR. The next step will be to integrate this data with airborne platforms to demonstrate the ability to locate and destroy ballistic missile launchers after launch.

Questor Grail

Questor Grail in FY 92 was the latest in a series of exercises conducted in support of theater CINCs to address the issues surrounding TBMs. It was held in conjunction with

EUCOM's Dragon Hammer 2 exercise. Major accomplishments of Questor Grail included TBM target database development, automatic input of cueing data to the PATRIOT, integration of naval forces into TMD operations, and the establishment of a warning and cueing net in EUCOM.

The Passive Sensor System (PSS)

The PSS is intended to detect and track TBMs using radio frequency (RF) emission sources from various transmitters of opportunity. The system is able to detect and track targets passively -- without disclosing its presence. It can also determine launch point and predict impact point, thereby supporting active defense, passive defense, and counterforce operations. In FY 92, the second generation prototype, PSS II demonstrated the first real-time tracking of TBMs (i.e., as the missile is flying, not recording data and processing at a later time to determine trajectories) in a test at WSMR using illuminators of opportunity. The next step is to demonstrate detection and tracking of TBMs at long range.

Israeli Test Bed Initial Operating Capability

The Israeli Test Bed entered its IOC in the Spring of 1992. The Israeli Test Bed is a cooperative venture (approximately 28% Israel, and 72% U.S.) which has developed a test bed unique to the Israeli environment for evaluation of Middle East missile defense designs and C^3I against defined threats. A follow-on joint U.S.-Israeli Experiment Program has been defined to use the Test Bed to optimize the Israeli missile defense of urban targets and to examine critical C^3I issues.

TMD Countermeasures Mitigation Program (TCMP)

On January 29 and February 11, 1993, TMDI conducted flight tests in the Pacific, firing from Wake Island toward Kwajelein, to collect radar and IR signatures in support of the TMD countermeasures mitigation program (TCMP). The first flight was a near-total success with data collected from ground- , ship- , and aircraft-based sensors. The second flight was a total failure with the M56 Minuteman I malfunctioning after approximately 35 seconds of flight; no data were collected.

6.2 FY 93/94 Milestones

Several key element milestones have been established for FY 93 and FY 94. These are listed below, followed by a discussion of each:

Sea-Based MS 0 DAB	April 1993
THAAD OPINE Decision	Summer 1993
BPI Study	July 1993
PATRIOT PAC-3 Missile MS IV Decision DAB	Fall 1993
AEGIS/SM-2 Block IVA MS IV DAB	January 1994
Sea-Based MS I DAB	Early 1995

THAAD

The THAAD missile system and the TMD-GBR system successfully completed a DAB Milestone I review in 1992, and THAAD successfully completed an Initial Design Review (IDR) in January 1993. They are both proceeding on a schedule that would support a UOES missile purchase decision in mid FY 94, with the UOES beginning early operational assessment in late FY 96. Significant program events for the objective systems include the Milestone II decision in FY 96 and a plan to assess the readiness for production in early FY 98. The full production decision is not planned until after FY 2000.

In addition to these major program decisions, two other major THAAD issues exist which require near-term decisions. These issues are:

1) the feasibility of the THAAD missile or THAAD missile derivative to serve as the interceptor for the sea-based element of TMD; and
2) the degree of nuclear hardening required in the THAAD system design to meet user requirements.

The first issue is of the cost and performance effectiveness of the THAAD missile or a THAAD missile derivative to serve as the sea-based ATBM interceptor. To resolve this, the contractor was to study the issue and report prior to the IDR. In addition, the Navy would examine technical and operational requirements for the interceptor and prepare an extensive COEA to collect data and evaluate cost, performance, and schedule impacts of alternative approaches including a modified Standard Missile design, a suitably modified THAAD, and an entire new missile development.

The contractor THAAD/AEGIS compatibility study presented prior to the IDR indicated that a totally common Army/Navy THAAD missile would cause expensive modifications to the AEGIS Weapons System and would decrease missile performance below Army requirements. Therefore, if the Sea-Based TMD COEA, due in July 1994, indicates that a Navy THAAD variant missile to be the most cost effective option, it is expected that DoD will maximize commonality at the subsystem level with the Army THAAD missile.

THAAD nuclear hardening requirements (Operation in Nuclear Environment or OPINE) was studied by the THAAD contractor within the first few months of the contract. The contractor focussed on design approaches that explored the range of system options from development of tactics with minimal hardening to complete in-flight missile hardening. The

contractor presented the cost, schedule and performance impacts of varying hardening options for the missile just prior to the IDR. A broader assessment of the appropriate hardening level for the ***overall TMD architecture*** has now been initiated by the OSD staff and a final decision on the THAAD hardening level will be determined after an OSD study is completed in July 1993.

Corps SAM

Currently, several contractor teams are working to define the concept for Corps SAM. Definition of Corps SAM may be affected in part by results of ERINT and PATRIOT developments, as well as integration and technology transfer from those and other programs.

Boost Phase Intercept

The current study of alternative vehicles and weapons for a BPI capability will be completed in mid-1993. At that time, a decision will be made concerning the establishment of a TMDI BPI development, demonstration or evaluation program.

PATRIOT

The decision on the exact technical components and capabilities of the PAC-3 missile is expected in the fourth quarter of FY 93, following completion of studies and tests in the multimode missile and ERINT missile programs. Two of the initial three test flights of the multimode seeker were successful. A fourth test flight is scheduled for FY 93. Lethality tests and warhead selection studies for the multimode missile are presently being conducted.

The first two ERINT control test flights have been successfully completed, and a total of eight ERINT flight tests are scheduled to be completed by the fourth quarter of FY 93. The last six tests will include target intercepts. Tests against the full spectrum of threats (including bulk chemicals, chemical submunitions, and air-breathing targets) are planned.

AEGIS/SM-2 BLK IVA

AEGIS SPY-1 Radar and Command and Decision System software modifications are underway in order to allow AEGIS ships to participate in near term TBM tracking exercises. Operational requirements documents were approved on December 30, 1992, and a Milestone IV decision is scheduled for January 1994. Operational software modifications will be completed in the mid term. Warhead changes, fuse modifications and seeker improvements to the SM-2 Block IV missile will progress to support a UOES in 1997.

Space-based and airborne tracking and cueing demonstrations are being defined and will be conducted in the mid-term. SPY-1 radar upgrades to double the range of the radar are being considered in the mid-to far-term.

Sea-Based Theater Missile Defense

A Milestone I DAB is scheduled to convene in early 1995 to select the approach for the Sea-Based ATBM and interceptor. This interceptor is envisioned as a long range, hit-to-kill weapon capable of providing wide area coverage of forces ashore, ports, airfields, and population centers. Candidates for this missile would be the LEAP, boosted by the Standard Missile Block IV rocket motor, a modification of the THAAD missile, or a new missile developed from existing or emerging technologies. The new missile could be derived from LEAP or THAAD kill vehicle boosted by an existing or new rocket motor.

A Cost and Operational Effectiveness Analysis (COEA) study will be convened in 1993 in order to collect data and evaluate the cost, performance and schedule impacts of the various proposed Sea-Based TMD interceptors. The focus of the COEA will be on upper tier, sea-based, theater-wide, hit-to-kill weapons for employment from AEGIS ships. This COEA will support the MS I DAB.

6.3 Near-term Experiments and Demonstrations

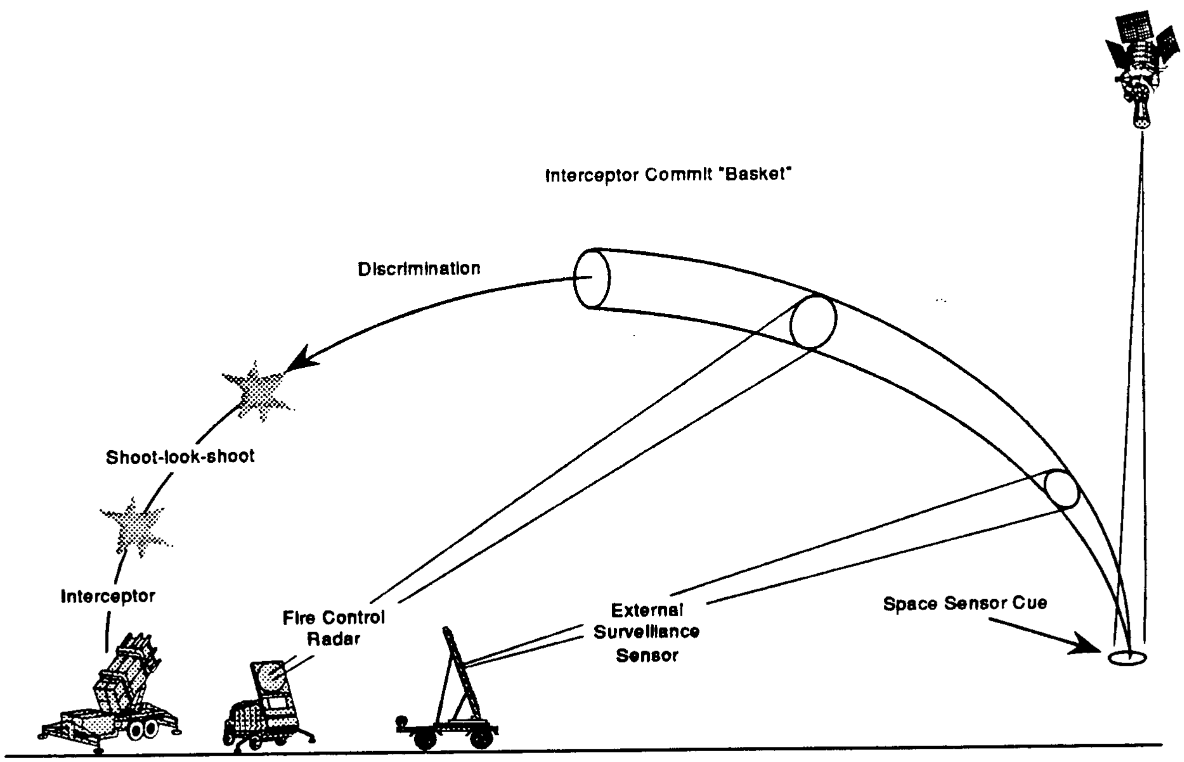
In accordance with the acquisition objective of demonstrating and exercising capability enhancements as rapidly as possible, a program of demonstrations has been planned for FY 93 and FY 94.

Several demonstrations are planned beginning in FY 93 to demonstrate PATRIOT capability enhancements. These demonstrations will lay the groundwork for future operations of these improved systems and fall into two functional categories: cueing of the PATRIOT radar, and discriminating TBM threat warheads from other debris. Cueing allows the PATRIOT radar to focus its energy into smaller areas, allowing earlier detection and tracking of incoming threats and subsequently larger defended areas. Better accuracy cues can provide longer range intercepts and fire control options. Discrimination of enemy warheads from debris reduces the need to fire PATRIOT missiles at debris caused by such things as the inadvertent breakup of Scuds witnessed in Desert Storm.

Figure 6.3-1 shows a framework for these demonstrations in an operational context. Because of the short timeframe, all of these early programs build on current systems. A schedule of demonstrations, along with the objectives, executing agent, and target demonstration dates are shown in Figure 6.3-2 and 6.3-3.

6.4 Key FY 93 Items and Issues

FY 93 will see a continuation of the efforts outlined in Chapter 3 with focus on the selection and design of key elements. Major decision milestones were addressed in Section 6.2, and the initiation of a near-term demonstration and experiments program was described is Section 6.3. Other issues and items receiving priority attention for FY 93 are presented below.



6.3-1. TMD Active Defense Geometry

ABM Treaty

Although the objective of the ABM treaty is to limit defenses against strategic ballistic missiles, there may be conflicts between the Treaty and the development or deployment of some TMD systems. DoD is currently studying this issue. In particular, resolution of this issue is required with respect to THAAD if its development is to continue at the planned rapid pace and a UOES capability is to be available by 1996.

Cruise and Air-to-Surface Missile Defense Integration

While TMDI does not have responsibility for theater cruise and air-to-surface missile defense, it is necessary that steps be taken by TMDI and the Services to ensure proper integration of TMDI and these defenses.

Title	Agent	Description	Location	Date
Space Sensor Cueing				
Talon Shield	USAF	- Demonstrate real time multi-satellite sensor fusion of launch detection data - Identify track accuracy, launch point and impact point estimate capability - Demonstrate real-time dissemination	Falcon AFB	4Q FY 93
Tactical Surveillance Demonstration (TSD)	USA	- Demonstrate upgraded stereo DSP capability, refined error reduction techniques, etc. - Identify track accuracy, launch point and impact point estimate capability - Demonstrate real-time dissemination	WSMR	1Q FY 93
Radiant Ivory	USN	- Demonstrate detection and track accuracy capability of other launch detection sensors against TBM targets	Multiple launches of opportunity	1Q FY 93
Surveillance Sensor				
TPS-59 Upgrade Tests	USMC	- Demonstrate extended range detection, high accuracy tracking of TBM targets	WSMR	4Q FY 93
Passive Sensor System Demonstration (PSS)	USA	- Develop and demonstrate improved (porcessor) tracking algorithms, antenna - Demonstrate extended range TBM detection and tracking capability - Identify track accuracy and launch point estimation capability	WSMR	3Q FY 93
TPS-75 Missile Tracker	USAF	- Demonstrate high accuracy tracking of TBM targets	WSMR	2Q FY 93

6.3-2. TMD Near-term Experiments And Demonstrations

Title	Agent	Description	Location	Date
		Fire Control Radar Cueing		
PATRIOT Cueing Demonstration	USA	- Develop PATRIOT radar cued search algorithms - Demonstrate extended range acquisition, track and intercept - FPS-16 and TPS-59 cues	WSMR / Pacific	2Q FY 93
Joint Service Track Fusion Demonstration (Cooperative Engagement Capability)	USN	- Conduct Joint Service tracking of a Wallops Island TBM launch - Use non-real-time track fusion processing	Wallops Island	1Q FY 93
		Discrimination		
PATRIOT Discrimination Demonstration	USA	- Develop and demonstrate discrimination algorithms for PATRIOT radar	WSMR	3Q FY 93
TMD Counter-measure Mitigation	USA / USN / USMC	- Collect flight test data on potential countermeasures	Pacific	2Q FY 93
		Sensor Netting		
Joint Service TMD Sensor Experiment	USN / USA / USMC / USAF	- Simultaneous data gathering on SPFE 3 flight test - SPY-1B, E-2C, TPS-59, PSS, PATRIOT, AWACS, and space sensors - Netting time lines identified non-real-time	Wallops Test Range	1Q FY 93
Modular Control Equipment (MCE)	USAF	- Develop and demonstrate sensor fusion and disseminationcapability of MCE	WSMR	4Q FY 93

6.3-3. TMD Near-term Experiments And Demonstrations (Cont'd)

Lethality

In FY 93, the Lethality Technology program will continue with twenty tests planned in direct support of the PATRIOT upgrade, ERINT, THAAD, and Arrow interceptor development programs. Hit condition variations with each interceptor type (fragmenting and hit-to-kill) will be tested against all threat warhead types. These sled tests are essential to supplement the planned Dem/Val flight tests for each of the TMD systems.

Countermeasures

To provide badly needed radar and infrared (IR) signature data of possible TBM countermeasures, the first of a series of the Theater Countermeasure Mitigation Program (TCMP) flight tests, focussing on missile breakup and fragments, were conducted in late January and early February 1993 with trajectories from Wake Island to Kwajelein in the Pacific. The data from these TCMP tests will be used to validate simulation models of countermeasures and to evaluate discrimination algorithms being employed by the sensors and weapons proposed for the lower and upper tiers of TMD. TCMP flight tests in future years will explore the range of possible enemy countermeasures.

Complete Definition of Air Force Program

By mid-1993, definition of the scope of the Air Force TMDI program in launch detection, counterforce, boost phase intercept, and C3I should be completed.

C^3I

Additional attention will be given to the issues of: a) exchanging surveillance data among Army, Navy, Marine Corps, and Air Force fire units and command centers; and b) coordinating the actions of the various Army and Navy fire units. Primary focus will be on interoperability and the development of standardized interfaces and messages which will be integrated into the existing theater air defense command and control system. Note that the above efforts address only C^3I associated with active defense against TBMs that are included under TMDI. There are additional Service C^3I efforts outside the scope of TMDI that address integration of TMD and air defense C^3I, including defense against theater cruise and air-to-surface missiles.

Flight Test Success

TMDI is undertaking a major effort to ensure the success of future testing by focussing on detailed design reviews and flight readiness checks. While Service executing agents plan

and conduct the actual flight tests, additional checks by TMDI are necessary and will be conducted.

Test Bed

With the availability of the EADTB in the fall of 1993, it is expected to be the common analysis tool for TMD studies. Much preparatory work is required to ensure that the facility achieves its full potential as early as possible. Exploitation of current or planned capabilities of the NTB to support TMDI will be under active study during FY 93.

THAAD/Arrow Interoperability

Consistent with the TMDI objective of promoting interoperability with ATBM systems of our friends and allies, it is desirable to explore how THAAD and Arrow could be compatible in the event that they fight side-by-side at some future date. Discussions with the Israelis are planned on this subject.

* * *

Chapter 6 in Review

- ***Significant TMDI program advancements were achieved in FY 92***
- ***Key milestones have been outlined for FY 93/94, including***
  - ***Sea-Based MS 0 DAB*** — ***April 1993***
  - ***THAAD OPINE Decision*** — ***Summer 1993***
  - ***BPI Study*** — ***July 1993***
  - ***PATRIOT PAC-3 Missile MS IV Decision DAB*** — ***Fall 1993***
  - ***AEGIS/SM-2 Block IVA MS IV DAB*** — ***January 1994***
  - ***Sea-Based MS I DAB*** — ***Early 1995***
  - ***A program of experiments and demonstrations has been outlined for FY 93 and FY 94.***

Chapter 7

Funding

Chapter 7
FY 93 and FY 94 Funding

Shown below is the actual TMDI funding for FY 93 and requested funding for FY 94, grouped into six major categories and a number of subcategories. The requested FY 94 TMD funding "for each program, project and activity" is given by program management agreement (PMA), by which funding and direction goes to executing agents in the separately-provided Congressional Descriptive Summaries. Each category is briefly described and the relevant PMAs are indicated. The prefix letters for the PMA indicates the executing agent as follows:

A = Army	D = Defense Nuclear Agency
E = Department of Energy	F = Air Force
N = Navy	S = BMDO

Name And Description	FY 93	FY 94
1. Acquisition		
This category includes the primary TMDI acquisition activities.		
1.1 Marine Corps (PMAs: S 2106/01, S 2213/01) Provide near-term TBM upgrades for the Marine Corps' AN/TPS-59 and HAWK.	18.703	24.349
1.2 PATRIOT/ERINT (PMAs: A 2207, A 2208) Upgrade PAC-2 system; develop and test ERINT missile system. Evaluate effectiveness and suitability of multimode missile, ERINT, improved launcher, radar Phase III, and other PATRIOT enhancements for PAC-3.	286.588	347.531

Acquisition, continued	FY 93	FY 94
1.3 Corps SAM		
(PMAs: A 2212) Continue concept definition for a lower-tier, tactically deployable TMD system to support deployed Corps, contingency operations, and rapid reinforcing missions.	23.000	31.998
1.4 Sea-Based TMD		
(PMAs: N 1210/01, N 2213/01) Develop software modifications to the AEGIS weapon system and initiate concept definition of the SM-2 Block IVA missile. Initiate R&D, testing and integration of promising interceptor technologies, including LEAP.	90.000	240.409
1.5 THAAD		
(PMAs: A 2210) Develop and test the THAAD weapons system as the ground-based upper tier of the TMDI.	273.000	484.270
1.6 TMD-GBR		
(PMAs: A 2104) Develop and test X-band radar TMD-GBR as a part of the THAAD system.	111.895	234.111
1.7 Boost-Phase Intercept		
Pending selection of a preferred BPI approach, there is no funding for acquisition in this area.	0.000	0.000
1.8 Brilliant Eyes		
(PMAs: F 2102) Fund TMD portion of development and acquisition of Brilliant Eyes.	0.000	112.518
1.9 Launch Detection		
(PMAs: A/N/F 2106) Complete development of the Talon Shield and Radiant Ivory programs to provide improved tactical processing of launch detection data; implement Army effort on TSD and JTGS.	20.500	21.488

Acquisition, continued	**FY 93**	**FY 94**
1.10 C³I		
(PMAs: F 3211/02)	0.000	0.000
Subtotal	**823.686**	**1496.674**

2. Architectures And Analytical Studies

This category includes architectural and analytical studies and development of supporting test beds.

2.1 Architecture, Integration and Balancing		
(PMAs: F 3212, S 3205, S 3208, S/A/F 3211, A/F 3213) Perform studies to ensure engineering and integration of TMDI with national missile defense; integrate Services active defense architecture and capabilities within overall TMDI architecture.	20.131	35.832
2.2 Test Beds		
(PMAs: A 3305/01/04/05/08) Develop computer-based simulations with man-in-the-loop and hardware-in-the-loop capabilities to analyze extended air defense and TMD systems.	36.250	35.366
2.3 Other Pillars		
(PMAs: A/F/S 3210, F 3211) Develop counterforce technical requirements, and conduct architecture and systems engineering studies to identify promising areas for exploitation.	2.570	5.859
Subtotal	**58.951**	**77.057**

3. Technical Support

This category includes essential technical activities which support all acquisition activities (Technical Base) and advanced development effort on sensors and weapons (Advanced Development).

Technical Support, continued	**FY 93**	**FY 94**
3.1 Technical Base		
(PMAs: A 1501, D 1502, A 1109) Define critical survivability issues for TMD elements and support TMD element survivability demonstrations. Develop -- through analyses, laboratory and field tests -- estimates of PATRIOT, ERINT, THAAD, Kinetic Energy Weapon (KEW) and Directed Energy Weapon (DEW) lethality against TBM threats carrying a variety of warheads. Define and conduct a series of representative flight tests to provide data for the development of countermeasure models and design of discrimination algorithms to operate in countermeasure environments.	42.500	39.439
3.2 Advanced Development		
(PMAs: S 1106, F 3213, F/E/S 2106, S/E 3205, A 1206) Conduct R&D on advanced sensor and weapon technologies to include focal plane array materials, algorithms, advanced warhead, electro-thermal guns, and directed energy weapons technologies. FY 93 funding includes RAPTOR/TALON BPI development.	34.505	6.737
Subtotal	**77.005**	**46.176**

4. Test And Evaluation

4.1 Targets and Test Support		
(PMAs: A 3004, S 3301, S 3309, S 3310, S3311, S3313) Support test and evaluation facilities, mobile test assets test ranges, and data centers. Funding of targets is included in the totals for the system/element using those targets.	**41.842**	**92.679**

5. Implementation And Integration

Early improvements to current TMD capabilities and planning for the UOES activities are included here.

Implementation and Integration, continued	FY 93	FY 94
5.1 CINC Initiatives		
(PMAs: S 3205) Support theater CINCs by funding TMD features added to scheduled exercises.	9.637	9.767
5.2 Near-Term Demonstration		
(PMAs: A 2106) Identify, test and demonstrate candidate TMD sensor systems, subsystems, and components for near term demonstrations and possible operational capability.	10.700	6.095
5.3 Other		
(PMAs: (S 2300/44, S 3102/B; A 3208/1)	4.922	4.395
Subtotal	**25.259**	**20.257**

6. International Programs

6.1 International Studies		
PMAs A/S 3205, A 3305, A 2209, A 1206) Jointly fund international systems engineering, analyses, concepts and architecture studies, and developments. This area includes the WESTPAC architecture, U.K. architecture study, U.K. AI discrimination, and Israeli SE&I and BPI study, and Arrow/ACES.	75.714	74.590
TOTAL:	**$1102.457**	**$1807.433**

Appendix

Element Summaries

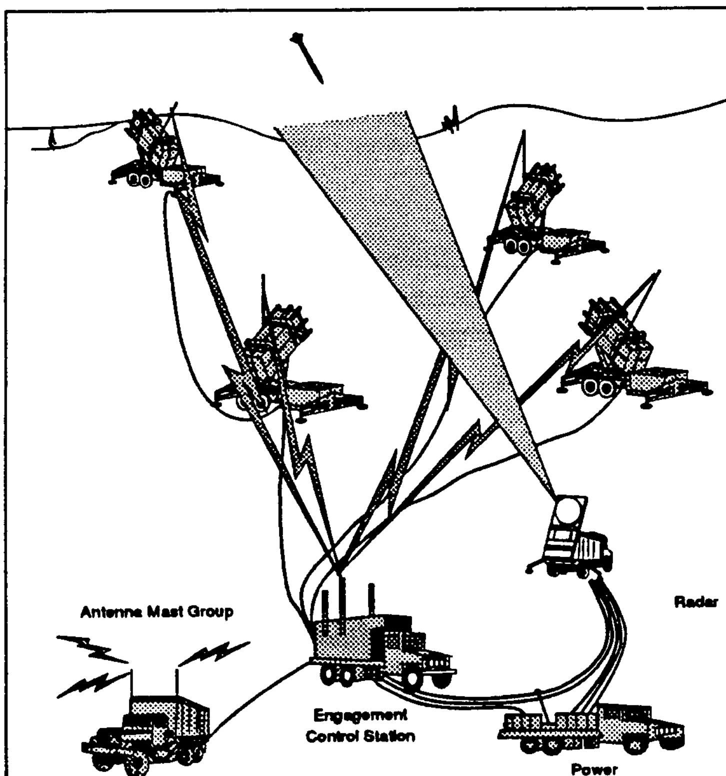
APPENDIX: Element Summaries

The sections which follow present a summary of the candidate system elements beginning with a short statement of current status.

A.1 PATRIOT

PATRIOT's fielded TMD capabilities are currently being upgraded through a material change process to incorporate near-term improvements to the radar and PAC-2 missile system. A major system upgrade (Milestone IV decision) to PATRIOT PAC-3 capability, including further radar upgrades and a new missile, is planned for the fourth quarter FY 93.

PATRIOT is a transportable system that provides a lower-tier capability. A PATRIOT firing battery consists of a Fire Control Section and associated launchers. (See Figure A1-1). The Fire Control Section consists of an Engagement Control Station (ECS), Antenna Mast Group (AMG), Radar Set (RS), and Electric Power Plant (EPP). The exact number of launching stations (LS's) in a firing battery is tailored to the particular situation and mission.



- **Multifunction Phased Array Radar For Multilaunching Stations**
- **Multilaunching Stations Mission Dependent (Remote)**
- **Manned Engagement Control Station (ECS)**
- **Key Support Equipment**
  - **- Antenna Mast Group**
  - **- Electric Power Plant**
  - **- Fiber Optics Links**
  - **- Cables**
  - **- VHF Radio Data Link**

A1-1. PATRIOT Firing Battery

The PATRIOT Anti-Tactical Capability-1 (PAC-1) system was originally designed to protect limited area military targets (e.g., an air base or military asset) against attack from air-breathing threats such as cruise missiles or manned aircraft. The PATRIOT interceptor uses a high explosive fragmenting warhead to destroy targets. PATRIOT was upgraded (PAC-2) to protect a limited area against faster moving, short range ballistic missiles. This was the capability demonstrated against Iraqi-modified Scuds in Desert Storm.

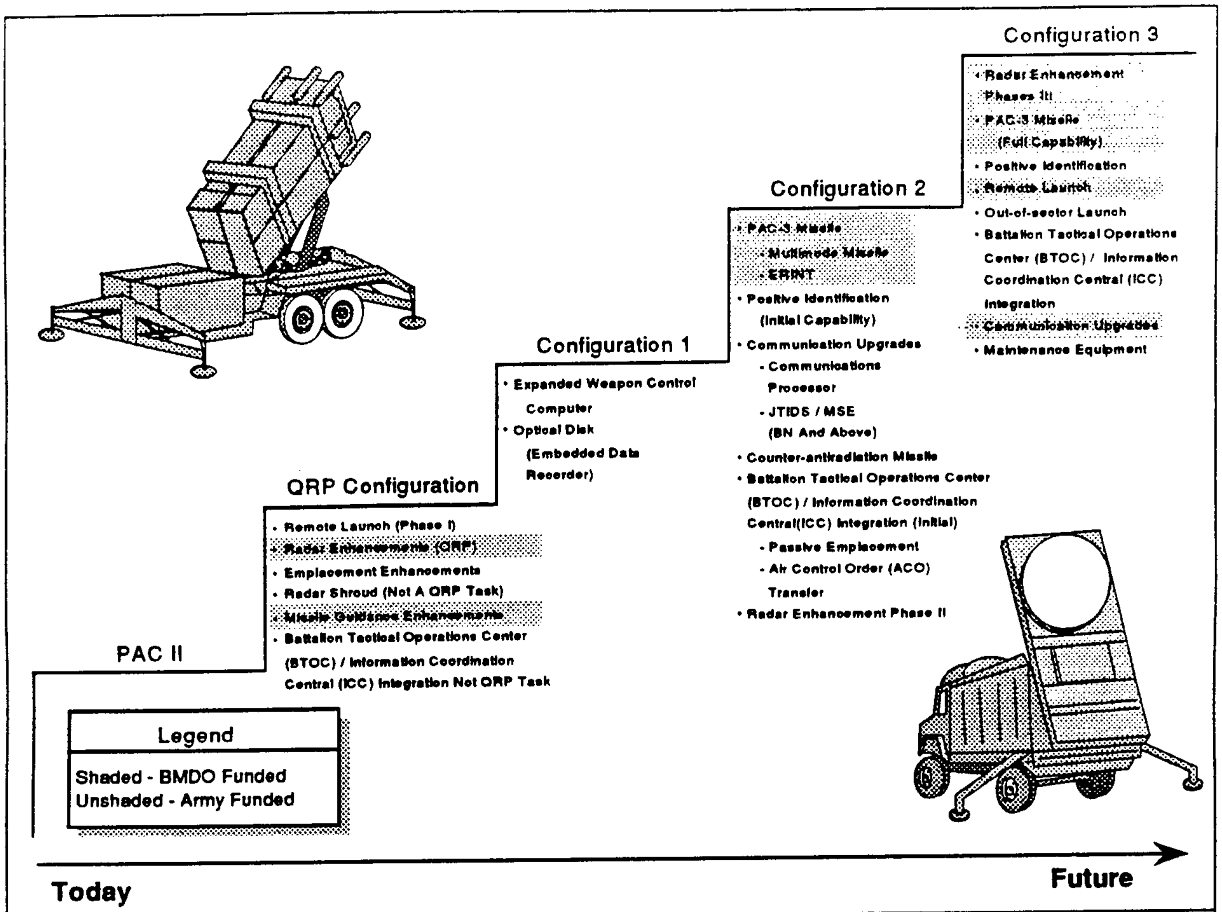
The baseline for TMD is PATRIOT PAC-2. Planned upgrades to the PAC-2 are a result of the Congressionally-mandated QRP, which includes enhancements to the radar to increase intercept range and performance. A companion program, the Guidance Enhanced Missile (GEM), includes engineering improvements to the PAC-2 missile. The QRP modifications are currently being fielded while limited GEM missiles will be fielded in 1995.

The planned PATRIOT PAC-3 will consist of a major system upgrade to the PATRIOT radar and a new missile (either multimode or ERINT). The PAC-3 requirement will lead to increased system battlespace and lethality capabilities. Included in the radar enhancements are increased radar detection range, positive target identification, engagement of targets with reduced radar signatures, extended fly-out range, increased firepower, and enhanced survivability. The specific capabilities of the PAC-3 system will be determined from studies on the utilization of technologies from both the multimode PATRIOT and ERINT missile programs. (See Figure A1-2.)

The multimode missile program is a PATRIOT missile improvement to PAC-2 which consists of guidance, lethality, and propulsion enhancements that provide essential increases in battlespace, accuracy, and kill potential required to counter the most stressing tactical missile and fixed wing threats of the future. The multimode missile or ERINT is scheduled for a MS IV decision to enter into EMD in the fourth quarter FY 93 timeframe. To support this decision, various flight tests of the multimode seeker and ERINT, lethality tests, and warhead selection studies are underway.

The missile seeker is an active Ka-band seeker in addition to the nominal track-via-missile guidance already existing in earlier PATRIOTs. The missile will fuze the warhead accurately using the missile seeker for information. The multimode missile seeker will also have a highly responsive autopilot.

ERINT is a technology demonstration program that represents a potential hit-to-kill missile candidate for active defense against TBMs and air-breathing threats. The ERINT missile is designed and built to be completely compatible with the PATRIOT system. Hit-to-kill technology, as opposed to blast fragmentation kills, may increase lethality against certain warheads. The ERINT flight test program will demonstrate a small (one-third the mass of PATRIOT), agile, prototype interceptor. The ERINT test program consists of six flight test intercepts in FY 93 that will demonstrate the effectiveness of hit-to-kill technology against TBM and air-breathing representative threats. To date the ERINT missile has successfully flown two control-test flights that have demonstrated the aerodynamic capabilities necessary to achieve hit-to-kill effectiveness. ERINT is designed to maintain an adequate keep-out zone against conventional and NBC warheads. The missile's onboard active Ka-band seeker and



A1-2. PATRIOT Growth Programs

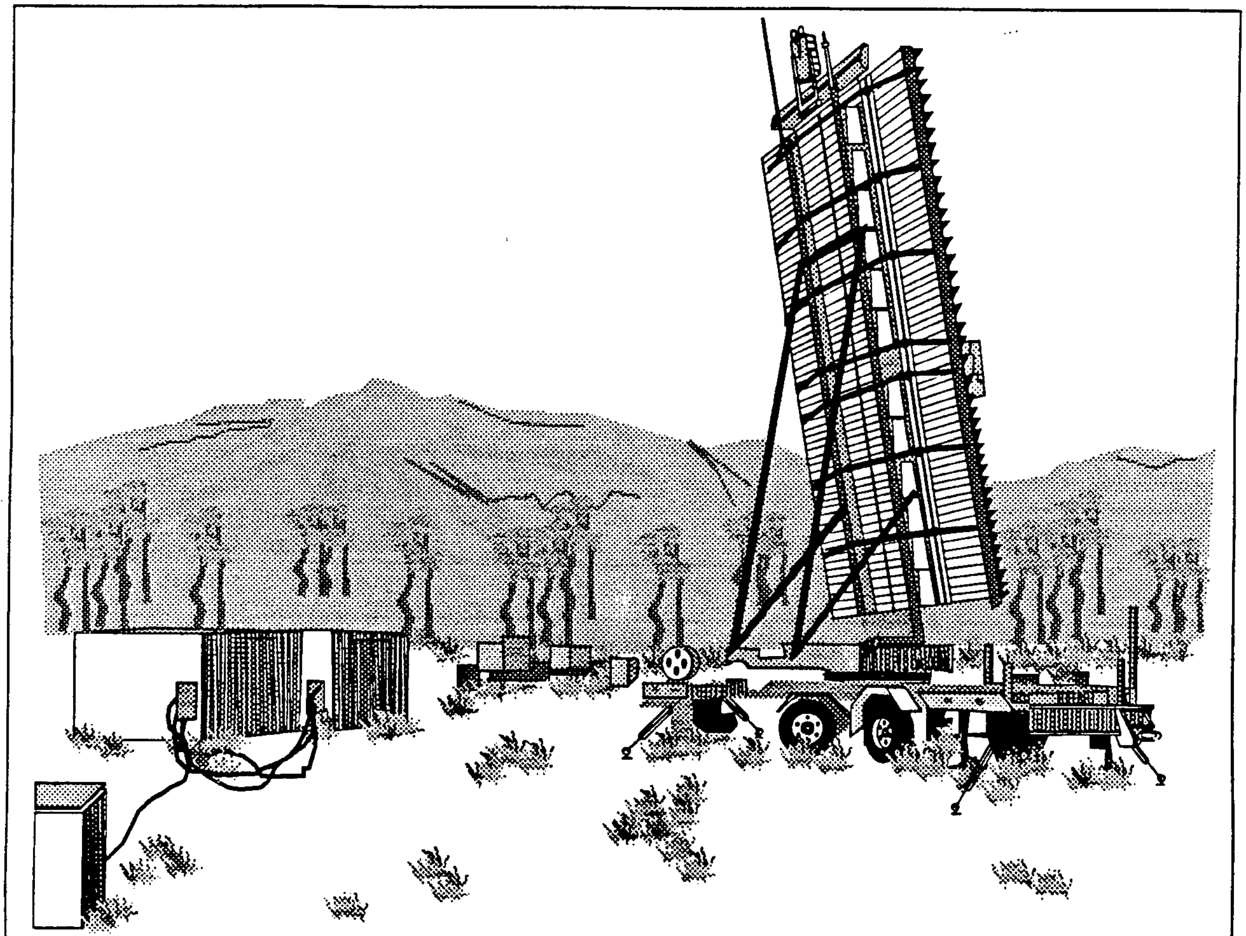
rapid aerodynamic response permit hit-to-kill accuracy. An ERINT system can provide agility in terminal maneuvers to counter maneuvering TBMs. Other state-of-the-art technologies include lethality enhancement and a lightweight composite case solid rocket motor.

There is an on-going PATRIOT/ERINT integration effort to ensure compatibility will exist in the future PAC-3 system. This integration effort addresses all aspects of ERINT integration into the PATRIOT weapon system lifecycle process to include logistics, training, maintainability, reliability, and producibility. The ERINT and multimode missile programs will be reviewed to approve an acquisition strategy that will involve one of the following combinations: dual development/single production, dual development/dual production, or single development/single production.

A.2 TPS-59 Radar and HAWK

Improvements are being made to the TPS-59 radar and HAWK weapon system to provide some TMD capability for Marine Corps operations.

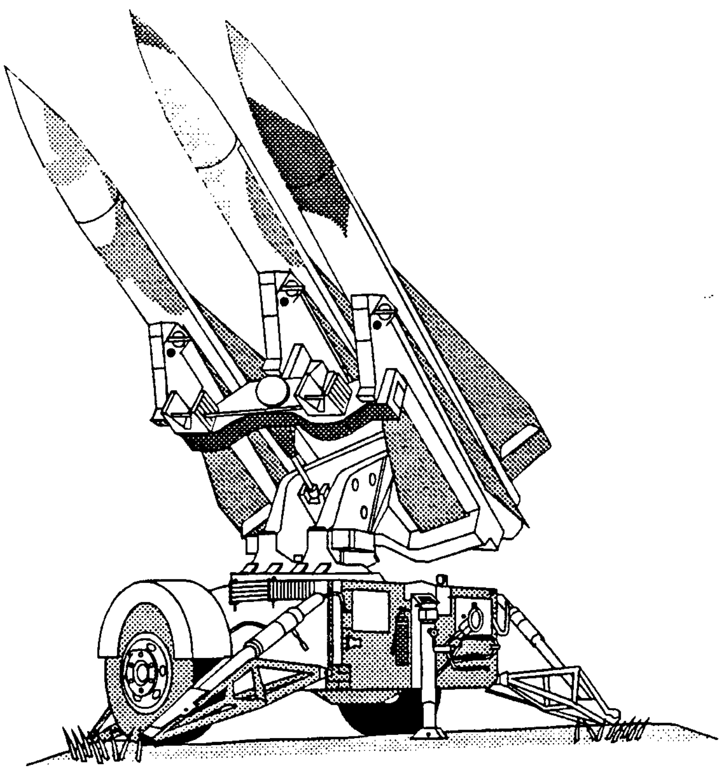
The Marine Corps' TMD initiative is jointly funded with BMDO and is intended to provide a low-risk, near-term capability for the USMC expeditionary forces. Upgrades and modifications to the prime sensor (AN/TPS-59 radar), the weapons system (HAWK), and the interface between the two (Air Defense Command Post or ADCP) are involved. The AN/TPS-59 radar (see Figure A2-1) will have a TMD mode incorporated which will result in detection



A2-1. AN / TPS-59 Radar Array

ranges of TBM targets out to 400 nm and 500,000 feet in altitude. Additionally, the radar will be able to provide cueing information for appropriate weapon systems via a JTIDS link. The HAWK Battery Command Post will be modified to accept the cueing data and control the High Power Illuminator radar as necessary. The ADCP serves as the interface, converting TADIL-J formatted messages into data link formats required by the HAWK weapon systems. (See Figure A2-2.)

Additional HAWK upgrades, funded solely by the Marine Corps, include incorporation of improved launchers, mobility improvements, and missile fuze/warhead changes.



A2-2. HAWK Missile Launcher

A.3 Corps Surface-To-Air Missile

Corps SAM is in concept definition with an initial operational capability after the year 2000. It is scheduled for a Milestone I decision in the fourth quarter FY 93 to enter into Dem/Val.

Corps SAM is an Army program currently in concept definition with an IOC after the year 2000. Corps SAM is expected to be a key element in the lower tier of TMD. It will be a low-to-medium altitude air defense and theater missile defense system designed to operate in the context of emerging Air-Land Operations doctrine and contingency theater operations associated with the rapid force projection needs of the future. As such, Corps SAM will protect critical fixed assets in the Corps' rear, Echelons Above Corps and mobile assets of the maneuver forces located in the expanding forward area of the Corps. It will provide effective 360-degree asset defense against the rapidly proliferating tactical missile threats and air-breathing threats. Corps SAM will be small, lightweight, and modularly configured to be highly transportable and mobile compared to current AD/TMD systems. It will be compatible/interoperable with other Army, Service, and allied systems expected to participate in joint/coalition operations.

The requirements for Corps SAM include:

- Transportability consistent with rapid force projection.
- Roll-on/roll-off capability and high tactical mobility, rapid road march/ emplacement.
- 360 degree area and asset defense of critical Corps and theater assets to include tactical assembly areas, command posts, forward area resupply points, etc, and critical areas required to allow the ground forces freedom to maneuver.
- High reliability and netted/distributed architecture (eliminates single point failure/ vulnerabilities nodes).
- Compatible and interoperable with other Army, Services and allied systems to ensure maximum coordination of the air defense battle in joint/coalition operations.

In addition to TMD, Corps SAM will have capability against air-breathing threats (cruise missiles, unmanned aerial vehicles, reconnaissance drones, and anti-radiation missiles).

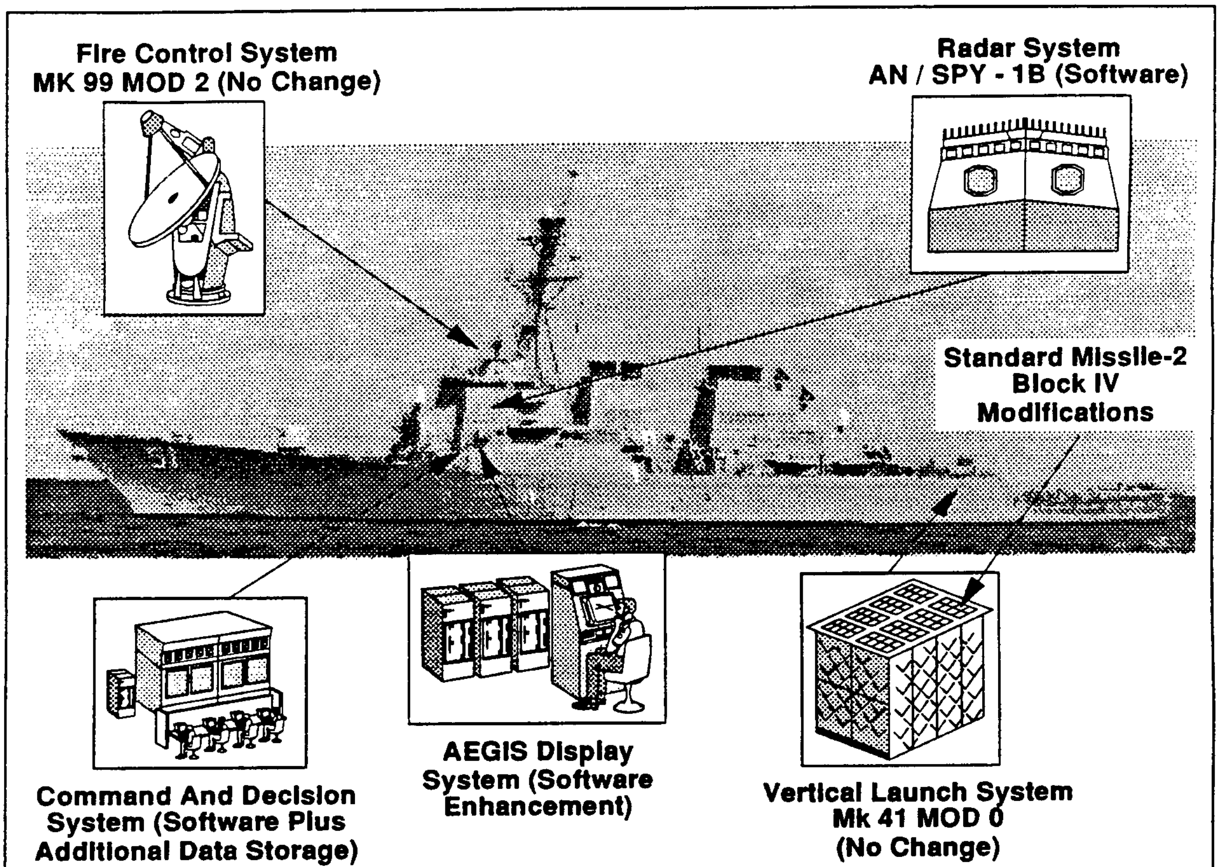
The Corps' Air Defense Capability MNS was approved in August 1990, and the Corps SAM program was approved at its Milestone 0 DAB review for entry into the Concept Evaluation and Definition Phase on August 6, 1990. Studies are being conducted by both government and industry that consider evolutions of currently fielded systems and development of new systems to define the most promising system concepts. These studies include cost, schedule, and performance trade-offs as well as system level evaluations. In July 1992, six prime contractors were awarded study contracts. Operational analyses are also being conducted to evaluate the impact of various concepts/ requirements on missions, force structure, and system effectiveness. A program (concept) baseline will be established that defines cost, schedule and performance objectives and an acquisition strategy designed to meet these objectives.

A.4 AEGIS/SM-2 Block IVA

AEGIS weapon system software modifications are in engineering development. Changes to the SM-2 Block IV missile to achieve a TMD interceptor are being designed.

The objective of this near-term Navy ATBM effort is to provide a PATRIOT PAC-3-like capability. In many cases the Navy would likely provide the primary initial response for a theater CINC faced with a TBM threat. This response might entail a relatively close-in area defense of fleet concentrations, debarkation ports, coastal airfields, amphibious objective areas, and expeditionary forces as they are inserted ashore. Accordingly, the proposed Navy TMD effort is structured to build on a substantial existing Navy infrastructure, including nearly 50 AEGIS cruisers and destroyers. These ships are already equipped with the SPY radar, VLS, and an extensive C^3I capability as a foundation for TMD capability. All elements of logistic support and the Navy personnel to operate and maintain the systems are in place.

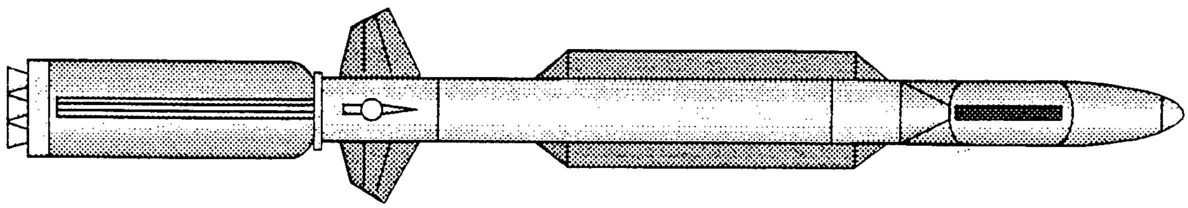
This proposed effort focuses on modifying the AEGIS SPY-1 Radar and Weapons Control System (WCS) software to enable TBM detection, tracking, and engagement by modified Standard Missile Block IV. (See Figure A4.1.) The SPY-1 radar computer programs will be modified to allow search at higher elevations and longer ranges in order to detect TBMs, and to maintain track on the extremely fast, ballistic targets. The WCS will predict intercept points and engagement boundaries for ballistic targets, initialize missiles, conduct firings and provide uplink commands as the missile flies to intercept the TBM. AEGIS displays and the shipboard Command and Decision System will likewise have their software modified to display TBM tracks and engagements and interface with other elements of the combat system.



A4-1. AEGIS Weapon System Mods

The SM-2 Block IV, currently in engineering development, provides the interceptor basis for the proposed initial sea-based TMD capability focusing on the more numerous, shorter range, lower apogee threats. As noted in Figure A4.2, changes to the baseline SM-2 Block IV warhead, seeker, and fuze to improve their performance against high speed ballistic missiles during intercepts within the atmosphere are being considered. Warhead modifications will capitalize on engineering analysis and design efforts already completed for the PATRIOT Missile. An adjunct IR seeker is being considered to reduce miss distance. The fuze will be improved to ensure proper performance in the high closing rate missile-to-missile encounters.

To the maximum extent possible, the modified SM-2 Block IV (designated SM-2 Block IVA) will retain capability against aircraft and anti-ship cruise missiles.



- **Add Infrared Seeker In Reserved Space**
- **Modify RF Guidance / Integrate With IR Seeker**
- **Modify MK 45 Fuze**
- **Modify MK 133 Warhead**
- **Increase Autopilot Speed**

A4-2. SM-2 Block IV Modifications For TMD

Following land-based and sea-based testing, a UOES should be available in 1997.

In addition to the DT/OT missiles planned to support testing in 1996 and 1997, 35 missiles will be procured for use with UOES AEGIS/SPY radar modifications if required for a mid-decade contingency. Low Rate Initial Production (LRIP) will begin in 1997.

A.5 THAAD and TMD-GBR

The THAAD system, including TMD-GBR, is currently in the Dem/Val phase of development with initial fight tests of the THAAD missile planned for the fourth quarter FY 94, and initial system tests planned to being in the fourth quarter FY 95. The Dem/Val phase is expected to lead to a UOES capability in late FY 96, and a Milestone II decision in the fourth quarter FY 96 to continue the program into engineering and manufacturing development.

The THAAD system consists of two separate but closely associated Army programs: the THAAD weapon system and the TMD-GBR. The THAAD system constitutes the upper tier of a two-tiered ground-based defense against TBMs. This system will provide broad coverage in a large interception envelope to defeat missile threats directed against wide areas, dispersed assets, and strategic assets such as population centers and industrial resources. THAAD will

engage at high altitudes to minimize damage caused by debris and chemical/nuclear munitions. The combination of high altitude and long-range intercept capability may provide multiple engagement (shoot-look-shoot) opportunities. The system will be interoperable with U.S. and NATO Air Defense systems and U.S. space-based sensors.

The THAAD weapon system includes missiles, launchers, C^3I units, and ground support equipment. The system will be C-130 transportable and will use existing standard government power supplies. The THAAD C^3I units will be compatible with the ADTOCs to enable communication to higher and lower echelons. Additionally, the THAAD C^3I will be able to accept cueing data from a variety of external sensors.

The THAAD missile is a single-stage, solid-fueled missile. Its dimensions are slightly less than that of a PATRIOT missile and weighs significantly less. The missile employs a thrust vector technology and a liquid divert and attitude control system. A target object map and predicted intercept point are provided to the missile prior to launch. The THAAD missile is capable of receiving inflight updates. Terminal guidance is provided by an infrared seeker looking through a side-mounted, uncooled window. The seeker window is protected by a shroud which separates prior to terminal homing. The THAAD missile ensures target lethality by destroying incoming warheads utilizing kinetic energy impact (hit-to-kill). It is capable of both endo- and exo-atmospheric intercepts.

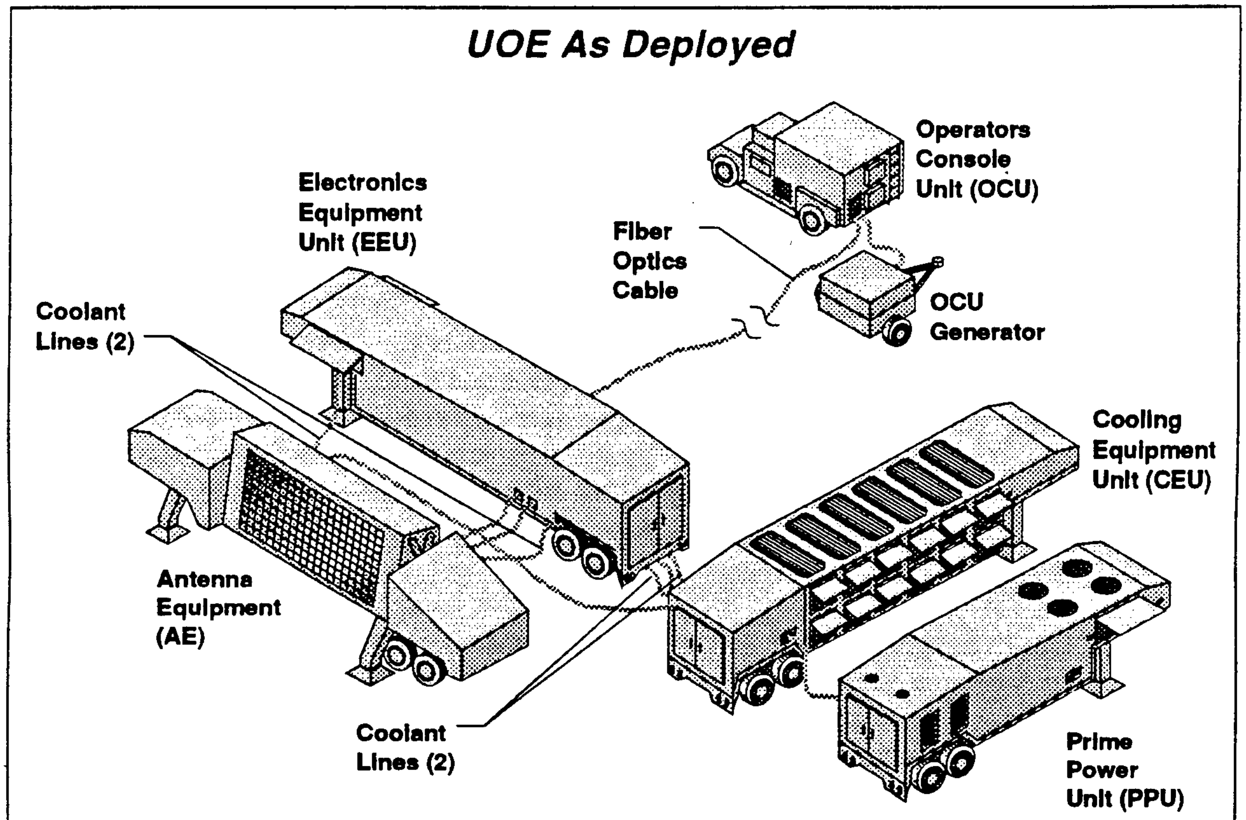
The THAAD launcher design consists of a 15-missile module mounted on a flatbed trailer. Primary power to the launcher is supplied by lead acid batteries that are automatically recharged by a tactical quiet generator. THAAD launcher requirements will be met using common Army logistics systems.

The C^3I system (Tactical Operations Center) is designed to provide automated acquisition and identification of TBM threats, processing and dissemination of track data, weapons assignment, engagement monitoring and sensor operation. The units are employed in the Standard Integrated Command Post System mounted on a high-mobility, multi-purpose wheeled vehicle. Reconfigurable for use at battalion or battery level, the networked architecture allows for maximum flexibility. The use of common hardware and software also allows cueing from external sources and cueing down to lower-tier systems.

The TMD-GBR will provide surveillance and fire control for the THAAD system. (TMD-GBR is part of a "family" of radars that support both the TMD and NMD missions.) Additionally, this radar provides an important theater-wide surveillance and discrimination function.

The TMD-GBR includes a trailer-mounted, single faced, phased-array antenna with solid state transmit/receive modules and trailer mounted equipment for organic power generation, system cooling, control and operations. (See Figure A5-1.) The radar operates at X-band and provides early warning of threat TBM launches by detecting and acquiring targets at very long ranges using autonomous horizon fence and volume search strategies of cued acquisition modes. The radar performs classification and discrimination to categorize the target type and identify the re-entry vehicle. The radar maintains track on the target and provides inflight updates to the missile prior to intercept. The TMD-GBR performs kill assessment to

support the decision to commit additional interceptors or cue lower-tier systems such as PATRIOT, Corps SAM, and the AEGIS weapon system.

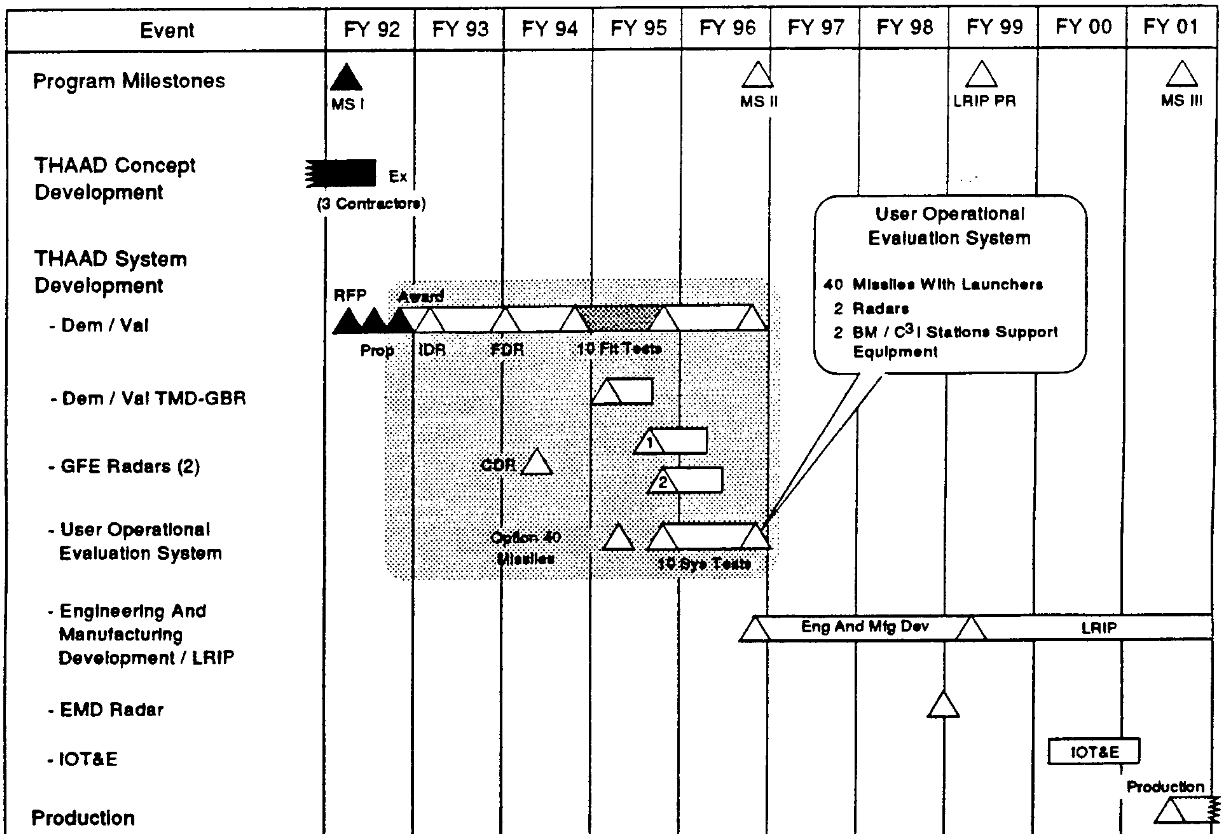


A5-1. TMD Physical Concept

The THAAD system program began in January 1989, with a System Requirements Study. In August 1990, three concept definition contracts were awarded to pursue initial development of the system. After the DAB granted approval in January 1992 to proceed with Dem/Val, contracts were awarded to Lockheed Missile and Space Company for the THAAD missile and to Raytheon for the TMD-GBR in September 1992. The THAAD program will deliver a functional, developmental prototype system at the end of the Dem/Val phase. This system, referred to as the THAAD UOES, will consist of 40 missiles with launchers, two C^3I units, two TMD-GBRs, and associated support equipment. The THAAD UOES supports early operational testing prior to entering the EMD acquisition phase. The THAAD UOES satisfies the need to provide, in case of a national emergency, a deployable prototype system by the mid-1990s in accordance with the Missile Defense Act of 1991. The DAB Milestone II review, to begin the EMD phase, will occur in September 1996.

The THAAD system program is shown in Figure A5-2. As shown, the test program will accomplish testing to support evaluation of the program's Dem/Val exit criteria. The test program will consists of ten missile flight developmental tests and ten system flight tests that

include limited operational testing to support the UOES development. All testing is scheduled to be conducted at WSMR. The first missile flight test will be in the fourth quarter FY 94.



A5-2. THAAD System Program Schedule

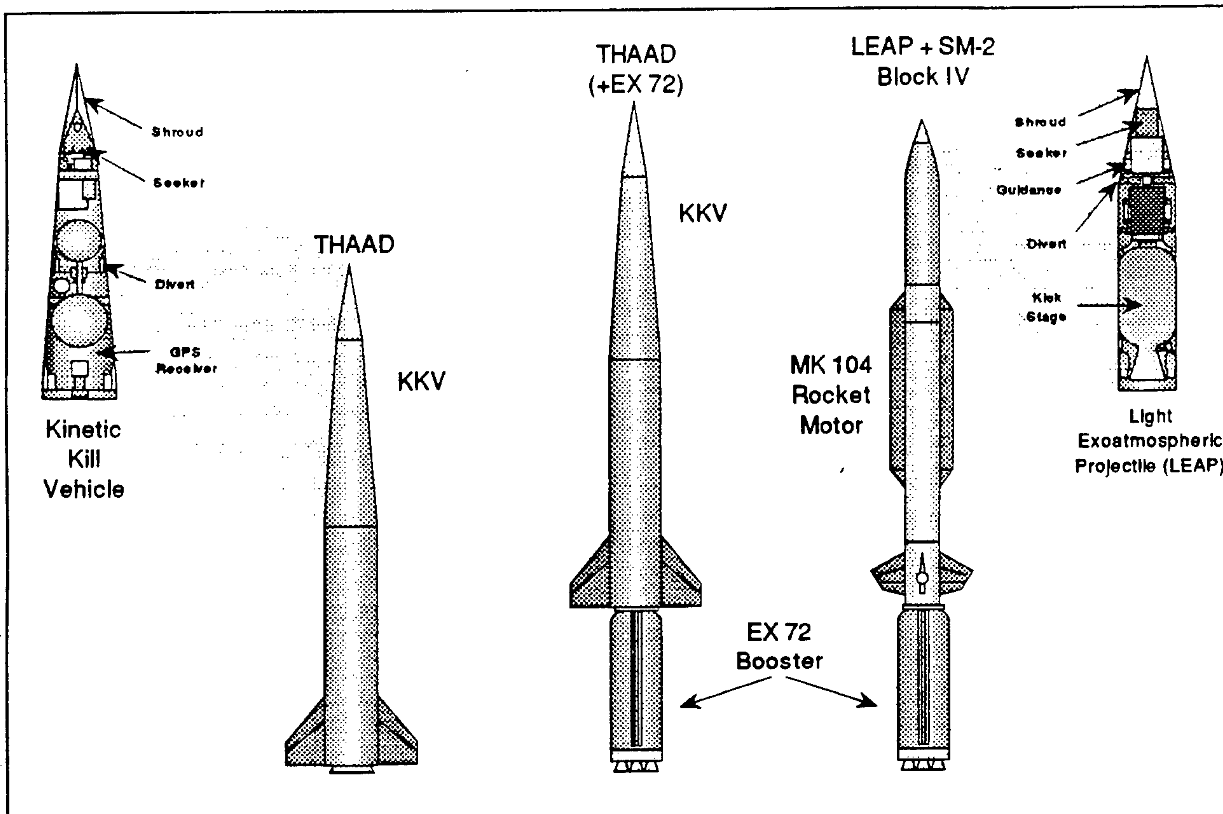
A.6 Sea-Based Theater Capability

The sea-based theater defense program is in concept definition with a Milestone O scheduled in April 1993. A 15-month COEA will commence in early 1993.

A new sea-based ATBM capability has been defined and forwarded by the JROC to the DAB and funded by TMDI. As noted in section A.4 above, the initial sea-based TBMD effort is expected to employ existing AEGIS ships with their SPY radars and VLS, together with modified Standard Missiles (SM-2 Block IVA) to provide an area defense capability. The longer-term capability could provide a wide area defense of joint forces, cities, vital assets and inland regions within an entire theater of operations. This role fully capitalizes on the inherent mobility and flexibility of naval forces.

The Navy is currently looking at options to achieve long-range intercept capability as rapidly as feasible. These options include a SM BLK IV booster-based interceptor with a KKV

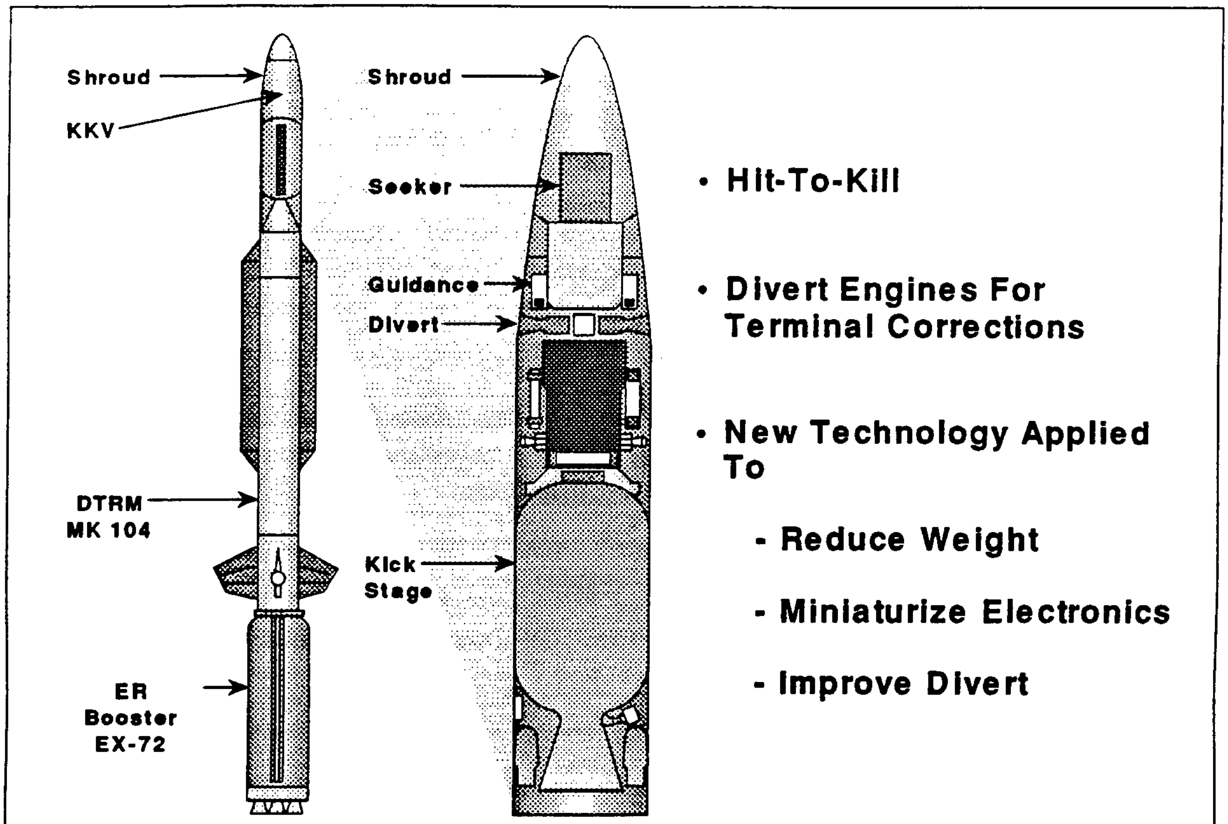
based on LEAP technology, a VLS-compatible THAAD variant, and other VLS-compatible interceptors utilizing state-of-the-art booster and KKV technologies. (See Figure A6-1.)



A6-1. Sea-based Theater Candidates

LEAP has been under development over the past several years. This effort is working to shrink the size and weight of hit-to-kill vehicles so they will fit in tactical size missiles, while at the same time improving sensor performance and divert capability. The Navy is supporting LEAP technology efforts through the on-going Terrier-LEAP Technology Demonstration. This program utilizes Navy Terrier (SM-2 BLK II/III (ER)) missiles as launch vehicles to demonstrate the intercept capabilities of LEAP KKVs. (See Figure A6-2.) The first ballistic flight test utilizing a modified Terrier missile occurred in September 1992. In this flight test, the missile was aerodynamically configured to be of the same size and weight as follow-on Terrier flights which will carry a LEAP vehicle. Following a series of Terrier LEAP demonstration flights, the program may transition to an advanced technology demonstration utilizing SM-2 Blk IV as launch vehicles.

The THAAD contractor is defining the design requirements for compatibility of the THAAD missile with the AEGIS WCS and shipboard VLS. Review of the requirements by the Navy and BMDO are ongoing. THAAD and THAAD variants will be included as alternatives in a BMDO-sponsored COEA for the Navy theater interceptor.



A6-2. Lightweight Exoatmospheric Projectile (LEAP)

In parallel, BMDO and Navy will conduct efforts to define C^3I architectural concepts to support a sea-based long range interceptor. These efforts will include studies and experiments to investigate space-based and airborne cueing, netting of theater sensors, and upgrades to the AEGIS SPY radar. These initiatives include demonstration and testing of airborne sensor assets that use RF and infrared technology to provide reliable, accurate and timely cueing.

This program is focused on achieving a sea-based theater TMD contingency capability in the late 1990s and a possible IOC early next decade.

A.7 Boost Phase Intercept

A BPI study is in the data-gathering/concept-formulation phase to assess the options available in the near-, mid-, and long-term to intercept theater ballistic missiles in the boost phase. The study will publish a final report in July 1993.

The AGM for TMD and the Technology Deputate of BMDO initiated a boost phase study at the beginning of FY 93. The study is intended to assess the goals and options for such intercepts and will develop the data necessary to make informed recommendations for a down

select decision by the third quarter FY 93. Key aspects of the study are: system concepts of operation (CONOPS) and Service integration, a consistent threat and baseline scenarios for analysis, agreed upon system performance measures, consistent lethality assumptions, consistent assessment of boost phase commit timelines, and top level cost and operational effectiveness analyses to understand true system utility.

The study is looking at six different concepts involving different platforms (manned aircraft and UAVs) and different weapons (kinetic energy versus directed energy). Key issues being addressed for these include the concepts of operations and the technical feasibility of the proposed boost phase interceptors. Other issues include:

- Operational effectiveness issues, including the ability to coordinate and respond within very short time lines, theater integration, coexistence with other theater assets, and the avoidance of fratricide.
- Emplacement of the weapon/sensor system in the theater and the maintenance of the system during a conflict.
- The cost and producibility of the various BPI proposed systems versus the effectiveness of these systems.
- Lethality issues as related to hitting the booster versus hitting the warhead.
- The ability to handle large numbers of missiles launched nearly simultaneously.
- The technical risk of the various proposed BPI systems and the ability to field these systems in the near to mid-term versus the far-term.
- The ability of the BPI system to survive the battle environment and countermeasures.

The study will also capitalize on an investigation of a UAV-based RAPTOR TALON concept for BPI which has been underway for the past year. In addition, the study will capitalize on joint BMDO-Air Force efforts to explore an airborne laser concept. Initial concept studies and supporting technology efforts were jointly funded, and the supporting technology efforts are planned to continue. Moreover, the Air Force plans to initiate an advanced technology demonstration project in FY 94 to develop a prototype system to explore the operational feasibility of the airborne laser concept to perform boost phase intercepts of tactical ballistic missiles. Funding for this effort was provided by the Air Force along with funding transferred from BMDO in accordance with Congressional direction to transfer responsibility for far-term follow-on technology efforts to DARPA or the appropriate Service.

A.8 Launch Detection

TMD launch detection programs are modifications to existing launch detection data (DSP and other) processing capabilities. While stereo DSP processing capabilities will be tested and exercised throughout FY 93, the next significant milestone will be demonstration

of the first real-time multi-satellite fusion of DSP and other launch detection data in the fourth quarter FY 93 on the Talon Shield program.

Processing of launch detection data supports TMD by providing early warning and impact region estimates, threat state vector estimates for cueing active defense elements, and launch point estimates for directing counterforce strikes against TBM launchers.

The current options for this processing include:

- Talon Shield, an Air Force fusion program with assets at Falcon AFB, operates with data from DSP and classified sensors.
- Radiant Ivory, a Navy program, performs sensor fusion processing using classified sensor data.
- TSD, an Army program, fuses direct downlink data from DSP. TSD is currently at WSMR and has successfully demonstrated stereo fusion of launch measurements during 1992.
- JTGS, a program to build a TSD facility for use in theater and at operations control sites.
- All four of these hardware efforts interface with the TRAP and TIBS networks in realtime, as well as other tactical data networks, providing a robust capability for users from all Services.

A.9 Brilliant Eyes

Brilliant Eyes is in the Dem/Val phase with four satellites (two from each contractor) scheduled for launch in the first quarter FY 97. The program will enter the EMD phase in the second quarter FY 98, leading to an IOC after FY 2000.

The BE system will be a distributed constellation of low earth orbiting surveillance satellites that supports both TMD and NMD and is being jointly funded. The BE system will also provide data on development, deployment, and testing of potential threats; this information can be used for sensor system optimization and block upgrade development for ballistic missile defense systems.

BE satellites will carry a suite of passive sensors including short-, medium-, and long-wavelength infrared and visible sensors. These sensors will acquire and track strategic and longer range TBMs in the boost phase and continue to track and discriminate the reentry vehicles from debris and penetration aids throughout the midcourse flight of the missiles. Low earth orbits will result in relatively short observation ranges to the missiles compared to geosynchronous satellites. These shorter ranges allow the BE sensors to detect smaller missiles and provide more accurate trajectory estimates throughout the missile's trajectory. The BE constellation is sized to provide global access to any theater worldwide on a moments notice.

BE can either be cued by a launch detector sensor or can be actively monitoring specific, predesignated small areas of interest in anticipation of missile launches.

The BE program is in the Dem/Val phase. Two contracts were recently awarded to Rockwell International and TRW. The Dem/Val program includes ground demonstrations of advance sensor designs and four flight demonstration satellites to demonstrate distributed surveillance support to TMD and NMD and resolve critical technical issues in support of the Milestone II decision in FY 98. Following a down selection to a single contractor, the EMD phase will commence to complete the BE system design and begin fabrication of LRIP satellites for DT&E and OT&E. Satellite deployments of the operational system are scheduled over a several year period.

BE target track and discrimination data can provide TMD lower and upper tiers with early, accurate data necessary to commit interceptors beyond the ground- and sea-based radar's range. BE will detect and acquire the missiles before they burn out. BE should be able to develop accurate track files on the missiles before burn out. By extrapolating the trajectory estimates backwards, BE is able to estimate the launch points accurately and timely enough to support counterforce operations. As BE continues to track the missiles after burnout, trajectory estimates are further refined to accuracies in which passive defenses can be more effective and interceptors can be committed and launched while the missiles are still beyond the radar horizon.

Utilizing cues from BE, ground-based radars can eliminate extensive search operations and focus their energy in the narrow regions of incoming missiles. This extends the radar range and allows earlier acquisition by the radar increasing its ability to provide earlier commit or target updates to interceptors. BE can pre-radar commit the interceptors providing more intercept opportunities, increasing the probability of eliminating the missiles, and reducing the collateral effect of intercept debris. This combined effect increases interceptor defended areas substantially for the longer range threats and could reduce the logistics requirements to defend the theater of operations.

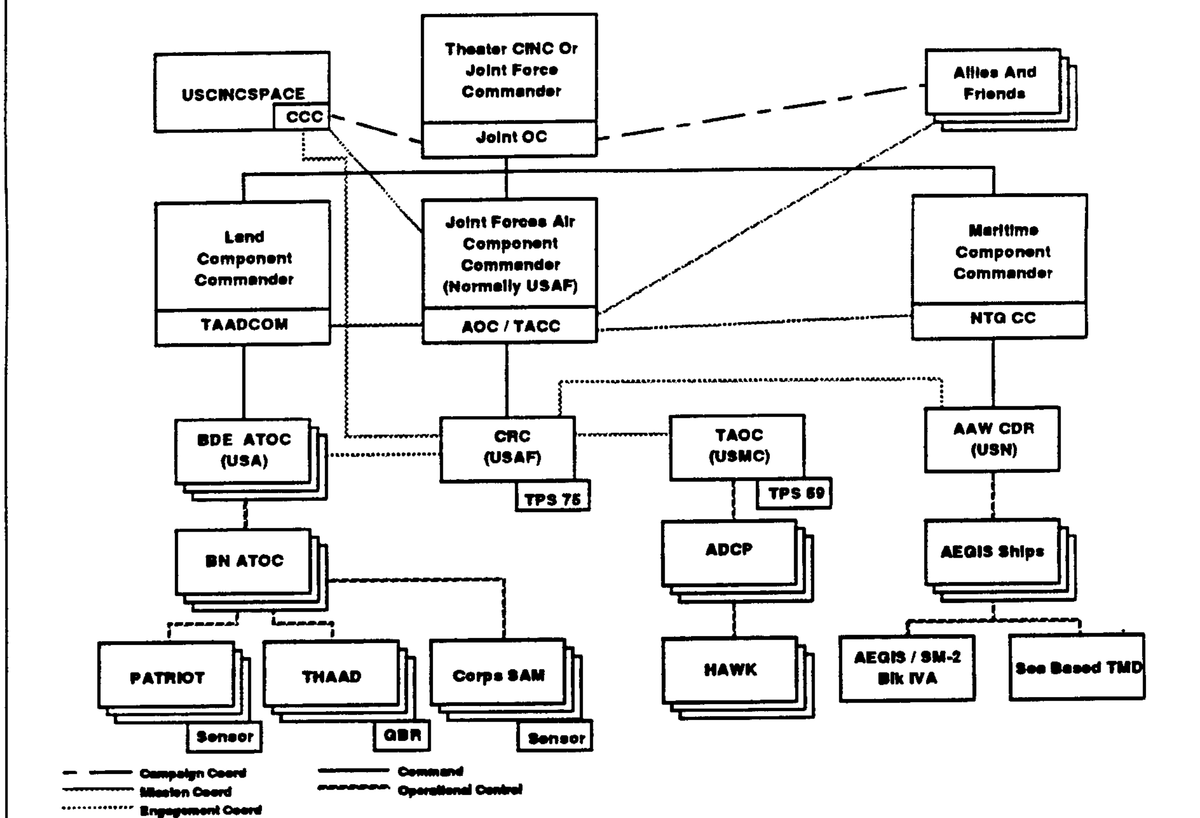
The missile tracking by passive sensors has an additional benefit of not being susceptible to radar jamming. The combination of BE's infrared and the GBR's radar data provides a powerful tool to discriminate between decoy and reentry vehicles, thereby reducing the system's vulnerability to countermeasures. In addition, using BE data to cue the radars reduces the time of operations thus limiting their susceptibility to anti-radiation weapons.

A.10 Command, Control, Communications and Intelligence

The TMDI C^3I builds on existing weapon systems, enhancing its performance with off-the-shelf technology.

C^3I systems provide the framework for synchronizing and integrating TMD active defense operations. C^3I provides the means to acquire the intelligence, access the tactical situations, determine course of action, and direct the implementation of approved plans and

orders. TMD active defense is an extension of air defense and, as such, TMD C^3I is considered an extension of the CINCs existing air defense command and control structure. Figure A10-1 illustrates how the various TMD elements would be integrated into the air defense command and control structure. The acquisition strategy takes advantage of the large inventory of C^3I assets already available in the theater and maximizes the use of existing command center and communications capabilities. This approach minimizes cost and provides enhanced combat capability early. Some modification will be required to the existing theater C^3I system to account for the unique features of theater ballistic defense. All modifications will stress interoperability and use of DoD data link standards.



A10-1. TBMD Command And Control Structure

The TMD C^3I system will also provide the communications between CINCSPACE and the theater CINCs Joint Force Air Component Commander. Existing communication links will be used to coordinate CINC activities for space-based sensor and weapon support. The MILSTAR satellite will be operational in the late 1990s and will provide a secure and interoperable low and medium data rate system for TMD command and control.

Space-based tactical warning and attack assessments from Talon Shield, using launch detection data (DSP and eventually FEWS), along with accurate cueing provided by Brilliant Eyes, will significantly enhance the performance of TBM defenses. The TMD C^3I architecture

builds on existing intelligence networks (TIBS/TRAP) to disseminate space-based cueing information from the processing center to the shooter in the battlefield. Special attention is being given to the communication interface and the regional capacity needed on existing satellite networks for near term capability using DSP. A central Tactical Processor is being developed to handle DSP, FEWS or BE.

Equally important to space-based cueing is the ability to rapidly disseminate surveillance and sensor data between active defense elements and across the TMD pillar. Several studies, including one conducted by the Air Force on behalf of BMDO, have identified the payoff of using the JTIDS for surveillance and warning. JTIDS should satisfy most TMD data dissemination needs and promote interoperability. JTIDS terminals will be included in the THAAD UOES. The Air Force, as the lead Service for JTIDS, will continue as the TMDI agent for implementing a JTIDS surveillance and warning network for ballistic TMD.

The ballistic missile defense function will require several new data messages for use on JTIDS and other DoD data links. The Joint Interoperability and Engineering Organization (JIEO) will act as the agent for TMD in the message set development. JIEO will ensure the messages meet and are incorporated into the DoD standards. A common set of messages will allow any Service and our Allies to receive and transmit near real time information across the battlefield.

The integration of battle management and command and control information is also necessary for successful interoperability. The potential for the Air Force Control and Reporting Center (CRC) for integrating information from different sources (TPS-75, TPS-59, TMD-GBR UOES, and TIBS/TRAP) and disseminating it to the forces, is one of the key issues which will be worked into the overall TMD architecture.

The potential for an Army ADTOC is also being addressed. The ADTOC refers to that set of modular, reconfigurable tactical operations center functions and supporting facilities that are fielded from battery to brigade in packages tailored in size and capability to each echelon and type of unit, but which are composed of common hardware and software.

The ADTOC exploits the commonality in command and control functions found at all levels in air defense artillery. These functions are characterized as engagement operations, fighting the battle, or force operations, planning and sustaining. The degree to which these functions are performed differs by echelon with batteries focusing on equipment operations and brigades on force operations. Currently these common functions are executed in a variety of nonstandard facilities which vary in sophistication, from manual to highly automated, and which use unique hardware and software. These unique nonstandard facilities are capable of very limited task organization, require specialized soldier training for operations and maintenance, and require separate logistics support to include hardware and software.

The objective of the ADTOC program is to eventually replace these systems with tailored command and control (C^2) packages composed of common hardware and software. The ADTOC will serve as the battery C^2 element for THAAD and PATRIOT, and the battalion C^2 element for task organized battalions conducting two-tiered defense of critical assets from

ballistic missile attack. The ADTOC will be the basis for the battery and battalion C^2 elements for Corps SAM.

The ADTOC acquisition approach leverages on common hardware and software and eliminates costly duplicative developments by individual programs. Weapon programs can focus on development of unique operational software and on interoperability requirements while drawing on already developed hardware and software--avoiding costly redundancy and duplication. This approach reduces operations and sustainment costs associated with separate training and logistics support systems, and eliminates acquisition and sustainment of very low density items.

* * *

Glossary

Abbreviations and Acronymns

Abbreviations And Acronyms

ABM	Antiballistic Missile
ABT	Air-Breathing Threat
ACES	Arrow Continuation Experiments
ACQ	Acquisition Costs
AD	Air Defense
ADCP	Air Defense Command Post
ADTOC	Air Defense Tactical Operations Center
AE	Acquisition Executive
AGARD	Advisory Group for Aerospace Research & Development
AGM	Assistant General Manager
AIS	Architecture Integration Study
AMG	Antenna Mast Group
ARC	Advanced Reserach Center at Huntsville
ASARC	Army System Acquisition Review Council
ASAS	Advanced Solid Axial Stage
ASM	Air-to-Surface Missile
ATBM	Anti-Tactical (or Anti-Theater) Ballistic Missile
ATD	Advanced Technology Demonstration
AWACS	Airborne Warning and Control System
BDA	Battle Damage Assessment
BE	Brilliant Eyes
BM	Ballistic Missile
BM/C^3	Battle Management/Command, Control, Communications
BMDO	Ballistic Defense Missile Organization
BPI	Boost Phase Intercept
C^2	Command and Control
C^3I	Command, Control, Communications and Intelligence
CED	Concept Exploration and Definition
CENTCOM	Central Command
CINC	Commander in Chief
CINCCENT	Commander in Chief, Central
CINCEUR	Commander in Chief, Europe

CINCPAC	Commander in Chief, Pacific
CINCSPACE	Commander in Chief, U.S. Space Command
CM	Cruise Missile
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept of Operations
CONUS	Continential United States
CRC	Control and Reporting Center
DAB	Defense Acquisition Board
DAE	Defense Acquisition Executive
DARPA	Defense Advanced Research Projects Agency
Dem/Val	Demonstration and Validation
DEW	Directed Energy Weapon
DoD	Department of Defense
DSB	Defense Science Board
DSP	Defense Support Program
DT&E	Developmental Test and Evaluation
DT/OT	Developmental Test/Operational Test
EAD	Extended Air Defense
EADSIM	Extended Air Defense Simulation
EADTB	Extended Air Defense Test Bed
ECS	Engagement Control Center
EMD	Engineering and Manufacturing Development
EPP	Electric Power Plant
ERINT	Extended Range Interceptor
EUCOM	Europe Command
FEWS	Follow-on Early Warning System
FOC	Full Operational Capability
FY	Fiscal Year
GBR	Ground-Based Radar
GEM	Guidance Enhanced Missile
GM	General Manager
GOJ	Government of Japan
GPS	Global Protection System
HATMD	High Altitude Theater Missile Defense
HAWK	Homing All the Way Killer

HE	High Explosive
HIL	Human-in-the-Loop
HWIL	Hardware-in-the-Loop
HQ	Headquarters
IABG	Acronym for a German contractor
IDR	Initial Design Review
ICC	Information Coordination Central
IOC	Initial Operating Capability
IR	Infra-red
IRST	Infrared Search and Track
ITB	Israeli Test Bed
ITW/AA	Integrated Tactical Warning/Attack Assessment
JCS	Joint Chiefs of Staff
JDA	Japan Defense Agency
JIEO	Joint Interoperability and Engineering Organization
JROC	Joint Requirements Oversight Board
JTF	Joint Task Force
JTGS	Joint Tactical Ground Station
JTIDS	Joint Tactical Information Distribution System
KEW	Kinetic Energy Weapon
KKV	Kinetic Kill Vehicle
LCC	Life Cycle Costs
LEAP	Lightweight Exoatmospheric Projectile
LRIP	Low Rate Initial Production
LS	Lanuching Station
LWIR	Long Wave Infrared
MIL	Man-in-the-loop
MMM	Multimode Missile
MNS	Mission Needs Statement
MOA	Memorandum of Agreement
MoD	Ministry of Defense
MS	Milestone
MWIR	Medium Wave Infrared

NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological and Chemical
NCA	National Command Authority
NMD	National Missile Defense
NTB	National Test Bed
NTF	National Test Facility
NTU	New Threat Upgrade
O&S	Operations and Support
OPINE	Operations In a Nuclear Environment
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OT&E	Operational Test and Evaluation
P^3I	Preplanned Product Improvement Program
PAC-2(3)	PATRIOT Advanced Capability-2 (or Capability-3)
PACOM	Pacific Command
PATRIOT	Phased Array Tracking to Intercept of Target
PEO	Program Executive Office
PM	Program Manager
PMA	Program Management Agreement
PMD	Program Management Directive
PSS	Passive Sensor System
QRM	Quick Response Missile
QRP	Quick Response Program
R&D	Research and Development
RF	Radio Frequency
ROE	Rules of Engagement
RPV	Remotely Piloted Vehicle
RS	Radar Set
SAE	Service Acquisition Executive
SAM	Surface to Air Missile
SBIR	Small Business Innovative Reserach
SDI	Strategic Defense Initiative
SDIAE	Strategic Defense Initiative Acquisition Executive
SDIO	Strategic Defense Initiative Organization
SDIARC	SDI Acquisition Review Council

SE&I	System Engineering and Integration
SHAPE	Supreme Headquarters Allied Powers Europe
SM-2	Standard Missile-2
SPACECOM	U.S. Space Command
STC	SHAPE Technical Center
SWIR	Short Wave Infrared
T&E	Test and Evaluation
TACS	Theater Air Control System
TBM	Theater Ballistic Missile
TCMP	Theater Countermeasures Mitigation Program
TEL	Transporter, Erector, Launcher
TEMP	Test and Evaluation Master Plan
THAAD	Theater High Altitude Area Defense
TIBS	Tactical Information Broadcast System
TMD	Theater Missile Defense
TMDAS	Theater Missile Defense Architecture Study
TMDI	Theater Missile Defense Initiative
TOC	Tactical Operations Center
TRAP	Tactical Receiver & Related Applications
TSD	Tactical Surveillance Demonstration
UAV	Unmanned Autonomous Vehicle
UK	United Kingdom
UKAS	United Kingdom Architecture Study
UKTB	United Kingdom Test Bed
UOES	User Operational Evaluation Systems
UTTMDS	Upper Tier Theater Missile Defense System
VLS	Vertical Launch System
WCS	Weapons Control System
WESTPAC	Western Pacific
WSMR	White Sands Missile Range

List Of Figures